MISSISSIPPI RIVER 9-FOOT CHANNEL,
LOCK AND DAM NO. 1
(Twin Cities Lock and Dam)
(Ford Lock and Dam)
in the Mississippi River at Mississippi Boulevard,
below Ford Parkway Bridge
St. Paul
Ramsey County
Minnesota

HAER No. MN-62

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
Rocky Mountain Regional Office
Department of the Interior
P.O. Box 25287
Denver, Colorado 80225

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MISSISSIPPI RIVER 9-FOOT CHANNEL, LOCK AND DAM No. 1
(Twin Cities Lock and Dam)
(Ford Lock and Dam)

Location: In the Mississippi River at Mississippi River Boulevard, below the Ford Parkway Bridge, City of St. Paul, Ramsey County, Minnesota.

Quad: St. Paul West

UTM: A 15/484000/4973160
B 15/484160/4973240
C 15/484980/4973260

Date of Construction: 1899-1917 (Modified 1910, 1932, 1947, 1950s, 1979-83)

Present Owner: United States Army,
Corps of Engineers,
St. Paul District

Present Use: Navigation and Hydropower.

Significance: Lock and Dam No. 1 is significant because it symbolizes important local and national events and trends, and because it possesses a rare and unique design. In 1894, Congress authorized two locks and dams for the Mississippi River between Minneapolis and St. Paul due to a rivalry between the two cities and because, at that time, two dams made sense to meet navigation requirements. National developments in hydropower technology and in the country's attitude toward its natural resources arrested the navigation project in full stride. Only the power of these developments--on national and local levels--explains why Congress ordered one of the new locks and dams destroyed and the other revamped. Those same issues created a decade-long debate so divisive that it immobilized the national government in terms of establishing its role in hydropower development. Lock and Dam No. 1 represents this debate, as Congress granted the Corps

authority to build the hydropower station base but not the plant and as six years would pass before the Ford Motor Company built its plant on this base. Because Congress revamped the original navigation project to include a high dam and hydropower, the Corps selected an Ambursen dam for Dam No. 1 and modified it in ways that make it a uncommon structure. Inseparably intertwined, politics, economics and technological developments explain how Dam No. 1 came to be and why it has a unique design.

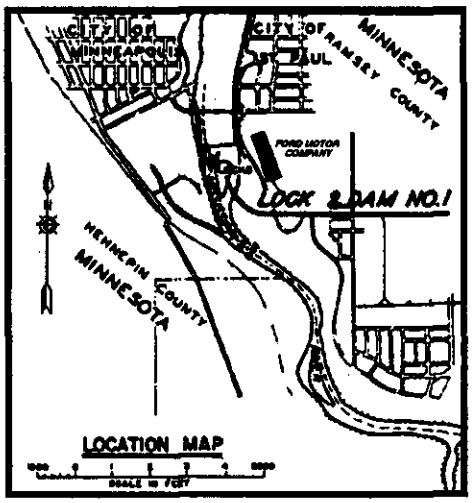
Historian: John O. Anfinson, Ph.D.
District Historian
St. Paul District
Corps of Engineers
August 1993

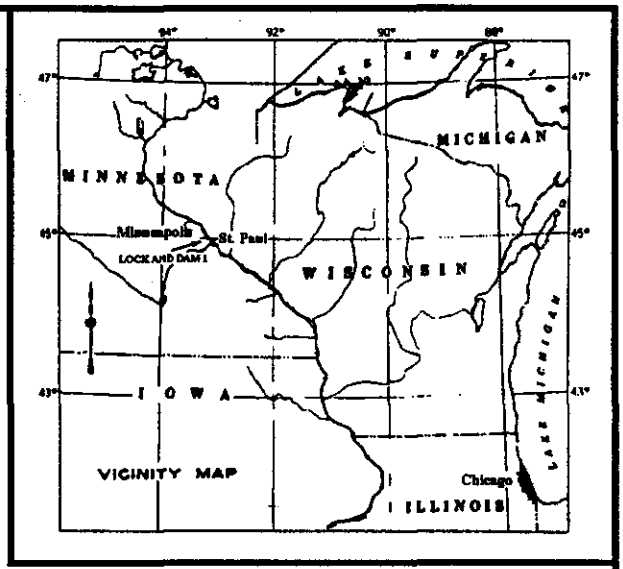
II. HISTORICAL SIGNIFICANCE

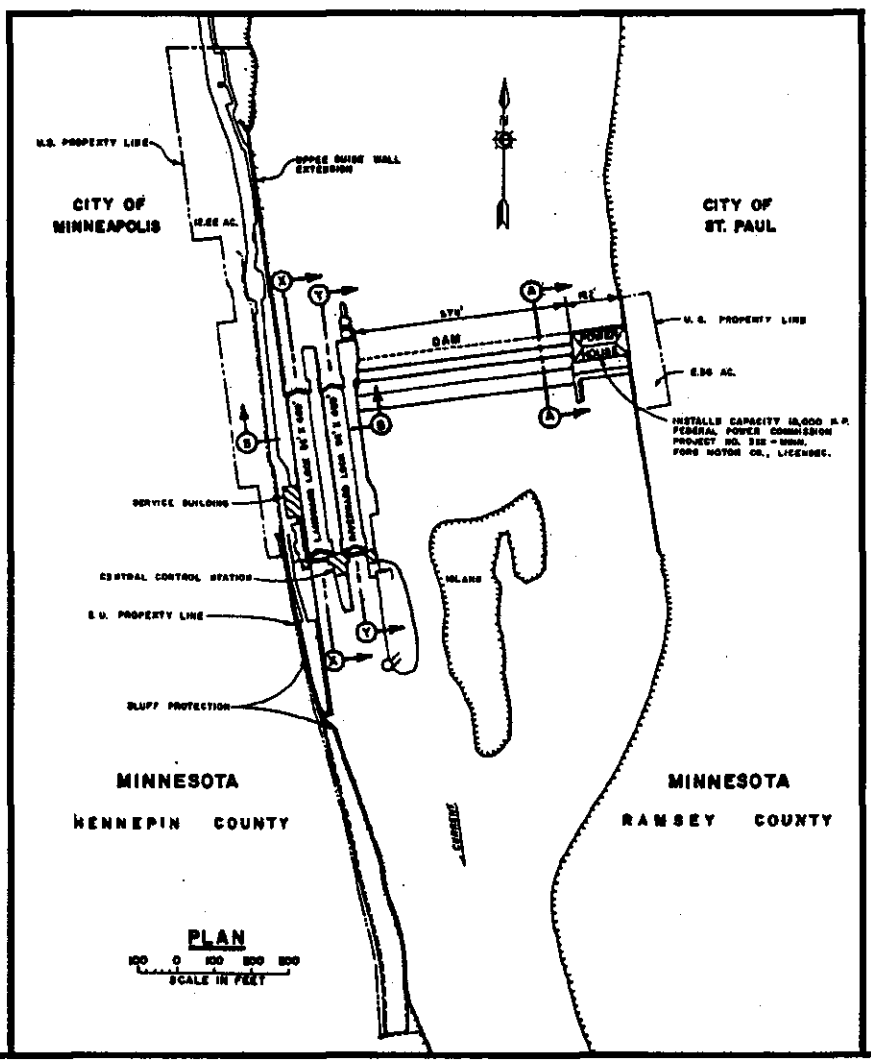
Five years after the United States Army, Corps of Engineers finished Lock and Dam No. 2--the first lock and dam on the Mississippi River--they destroyed it. When completed in 1907, the structure had cost over one million dollars. The Engineers also blasted out the floor of Lock No. 1, which they had nearly finished, and had to significantly rebuild its walls. When finally done, the reservoir created by this second lock and dam submerged the remains of the first. The new structure featured the base of a hydropower plant, but no plant was built over it for another six years, and then by a private company. Yet, the reason for destroying the first lock and dam and rebuilding the other was to capture the river's hydropower potential between the two cities.

The reasons for these incongruencies are embedded in local and national events and rivalries. A rivalry between St. Paul and Minneapolis explains, in part, why Congress authorized two locks and dams, where one would have served best. The emergence of a national conservation movement, the demand for efficiency that characterized the Progressive Era and the coming of age of hydroelectric power explain, in part, why Congress changed a project so far into construction. A national debate over the role of the Federal government in hydroelectric power development--a debate over which the government became deadlocked--explains, in part, why no one built a hydropower plant at the lock and dam until six years after the Corps completed it. The full story behind the

Existing Conditions, 1982







project to dam the Mississippi River between Minneapolis and St. Paul involves many interrelated factors.

To capture the hydropower potential of the Mississippi River between the Twin Cities required raising the height of Lock and Dam No. 1 from 13 feet to over 30 feet. To achieve this height, the Engineers selected an Ambursen dam, a unique and innovative structure for its time. They then modified the structure in ways that increased its uniqueness, making it a rare and possibly singular structure.

For this innovative design and the project's complex history, Dam No. 1 has been determined eligible for the National Register of Historic Places. As the Corps of Engineers plans to replace or remove the machinery that operates sluicegates in the dam, the St. Paul District has agreed to document this structure through a short history and photographs. (Map 1)

III. A RIVER RIVALRY

A. Origins

Based on their ties to the Mississippi River, Minneapolis and St. Paul, Minnesota, grew along separate and successful paths. St. Paul became a bustling port city and Minneapolis the nation's leading milling center. Each city jealously guarded that which made it flourish and tried to capture the source of their neighbor's affluence. Both cities began exploiting their tie to the river during the 1820s and by the Civil War had become prosperous communities.

Paddling upstream from St. Louis, Missouri, to St. Paul in 1823, the Virginia became the first steamboat to navigate the Upper Mississippi River. Steamboat traffic grew slowly over the next two decades. In 1841, St. Paul recorded 44 steamboat arrivals, and 95 in 1849. During the 1850s, traffic boomed. In 1857 and 1858, St. Paul counted over 1,000 steamboats arrivals each year (table).[1] As rapidly as steamboat traffic increased, it could not keep pace with demand. In 1854, the Minnesota Pioneer, a St. Paul newspaper, reported that passengers and freight overflowed from every

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[1]Mildred Hartsough, *From Canoe to Steel Barge*, (Minneapolis: University of Minnesota Press, 1934), pp. 57, 100-103; Frank Haigh Dixon, *A Traffic History of the Mississippi River System* (Washington: Government Printing Office: 1909):20. Lead, mined around Galena, Illinois, and in the adjoining lands in Wisconsin and Iowa, had been an important commodity from the late 1820s to the late 1840s. See William J. Peterson, "Captains and Cargoes of Early Upper Mississippi Steamboats, *Wisconsin Magazine of History* 13 (1929-30):227-32, and Hartsough, *Canoe*, 65-66.

steamboat that arrived and that "the present tonnage on the river is by no means sufficient to handle one-half the business of the trade."[2] While two steamboats often left St. Paul each day, they could not carry merchandise away as quickly as merchants and farmers deposited it.[3] Each steamboat that docked created new business and a greater backlog, as more immigrants disembarked to establish farms and businesses.

Table 1 Number of steamboat arrivals at St. Paul, 1844-1857.

1844.....	41	1854.....	256
1845.....	48	1855.....	560
1846.....	24	1856.....	837
1847.....	47	1857.....	1,026
1848.....	63	1858.....	1,090
1849.....	95	1859.....	802
1850.....	104	1860.....	776
1851.....	119	1861.....	772
1852.....	171	1862.....	846
1853.....	200		

(Sources: Frank Haigh Dixon, A Traffic History of the Mississippi River System, Washington: Government Printing Office: 1909, p. 20; Mildred Hartsough, From Canoe to Steel Barge, Minneapolis: University of Minnesota Press, 1934, p. 100.)

Few steamboats traveled above St. Paul to Minneapolis. Limestone boulders, left by the retreat of St. Anthony Falls, and a narrow gorge made travel on this reach treacherous. Shortly after the glaciers withdrew from southern Minnesota some 10,000 years ago, St. Anthony Falls stretched across the river valley near downtown St. Paul. A thick limestone mantle formed the river bed. Just below this mantle lay a soft sandstone layer. As water and ice eroded the sandstone out from underneath the limestone at the edge of the falls, the limestone broke off in large slabs, and the falls receded. Between downtown Minneapolis and downtown St. Paul, the river fell more than 100 feet. This steep slope, combined with the narrow gorge and the limestone boulders, created a fast flowing and dangerous passage. Thus, St. Paul became the head of navigation.

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[2]Hartsough, *Canoe*, p. 103.

[3]Ibid., pp. 101-102.

As St. Paul developed into a leading port city, Minneapolis blossomed into the nation's greatest milling center. While the falls turned back steamboats daring or desperate enough to venture that far, they gave Minneapolis the preeminent hydropower source in the central United States. Soldiers from Fort Snelling built a grist and sawmill at the falls in 1823, but significant development did not begin until after 1837. By the 1850s as many as 16 sawmills crowded the falls. During the 1860s and 1870s, flour mills replaced sawmills, the latter converting to steam power. In 1880, Minneapolis became the nation's leading milling center, its 27 mills producing over two million barrels of flour annually. Minneapolis would retain this title for 50 years.[4] In 1882, the nation's first hydroelectric plant, furnishing lighting for the Minneapolis business district, began operating at the falls, marking another phase in hydropower development.[5]

Minneapolis civic and commercial boosters wanted more than milling. They yearned to make their city the head of navigation. As early as 1850, they had tried to convince shippers that steamboats could reach the falls. To demonstrate this, they offered the steamer Lamartine $200 to venture from St. Paul to the cataract.[6] While contending that steamboats could easily reach Minneapolis, commercial boosters began discussing a lock and dam by 1852. Over the next five years the city's newspapers, civic leaders and the Territorial Legislature called for locks and dams to carry the booming steamboat trade to Minneapolis. In 1852, the St. Anthony Express suggested that the territorial delegate submit a bill to Congress for improving the river below the falls and in 1855 proposed that two locks and dams be built--one near Meeker Island and the other at the falls.[7] In 1858, when Minnesota became a state, the new legislature sent a memorial to Congress requesting that it fund improvement of the river above St. Paul. To encourage traffic, citizens of Minneapolis raised funds during the 1850s to remove boulders and other obstacles from the river below the

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[4]Lucile M. Kane, *The Falls of St. Anthony: The Waterfall that Built Minneapolis*, (St. Paul: Minnesota Historical Society Press, 1987), p. 99; originally published as *The Waterfall that Built a City: The Falls of St. Anthony in Minneapolis*, 1966.

[5]Lucile M. Kane, "Rivalry for a River, the Twin Cities and the Mississippi," *Minnesota History* 37:8 (December 1961):309.

[6]Ibid., p. 310.

[7]Ibid., p. 312.

falls.[8] Still, navigation boosters knew they needed locks and dams to bring a steady flow of steamboats to Minneapolis. (Map 2)

B. Early Efforts

In 1857, Bradley B. Meeker and Dorilus Morrison formed the Mississippi River Improvement and Manufacturing Company with a group of Minneapolis businessmen and proposed building a lock and dam between Minneapolis and St. Paul.[9] Meeker, a territorial judge, and Morrison, a St. Anthony Falls sawmill operator, lobbied for and obtained permission from the Minnesota Territorial legislature to build a lock and dam near Meeker Island and capture the hydropower from it.[10] Gone now, Meeker Island was located some three and one-half miles below the falls. Portending the coming conflict with Minneapolis, St. Paul citizens objected to the project.[11] The economic Panic of 1857 and the Civil War stalled the Mississippi River Improvement and Manufacturing Company's plans and postponed the conflict.

In 1865, Meeker and Morrison beseeched Congress for a land grant to fund their project. Supporting them, the Minnesota legislature, in 1866, memorialized Congress to authorize improvements for the river above St. Paul, and Minnesota Representative Ignatius Donnelly introduced a bill for the land grant. While Congress rejected Donnelly's bill, it did fund a survey of the river below the falls.[12]

In a separate act in 1866, Congress authorized the Corps of Engineers to survey the upper Mississippi River, including the river between Fort Snelling and St. Anthony Falls. To carry out these surveys, the Corps established a district office in St. Paul, making the Federal government an important player in efforts to improve the river to St. Anthony Falls. Brevet Major General Gouveneur K. Warren, the first St. Paul District commander, engaged Franklin Cook, a sometime employee of the Minneapolis Mill Company, to undertake the survey of the river between St. Anthony Falls and

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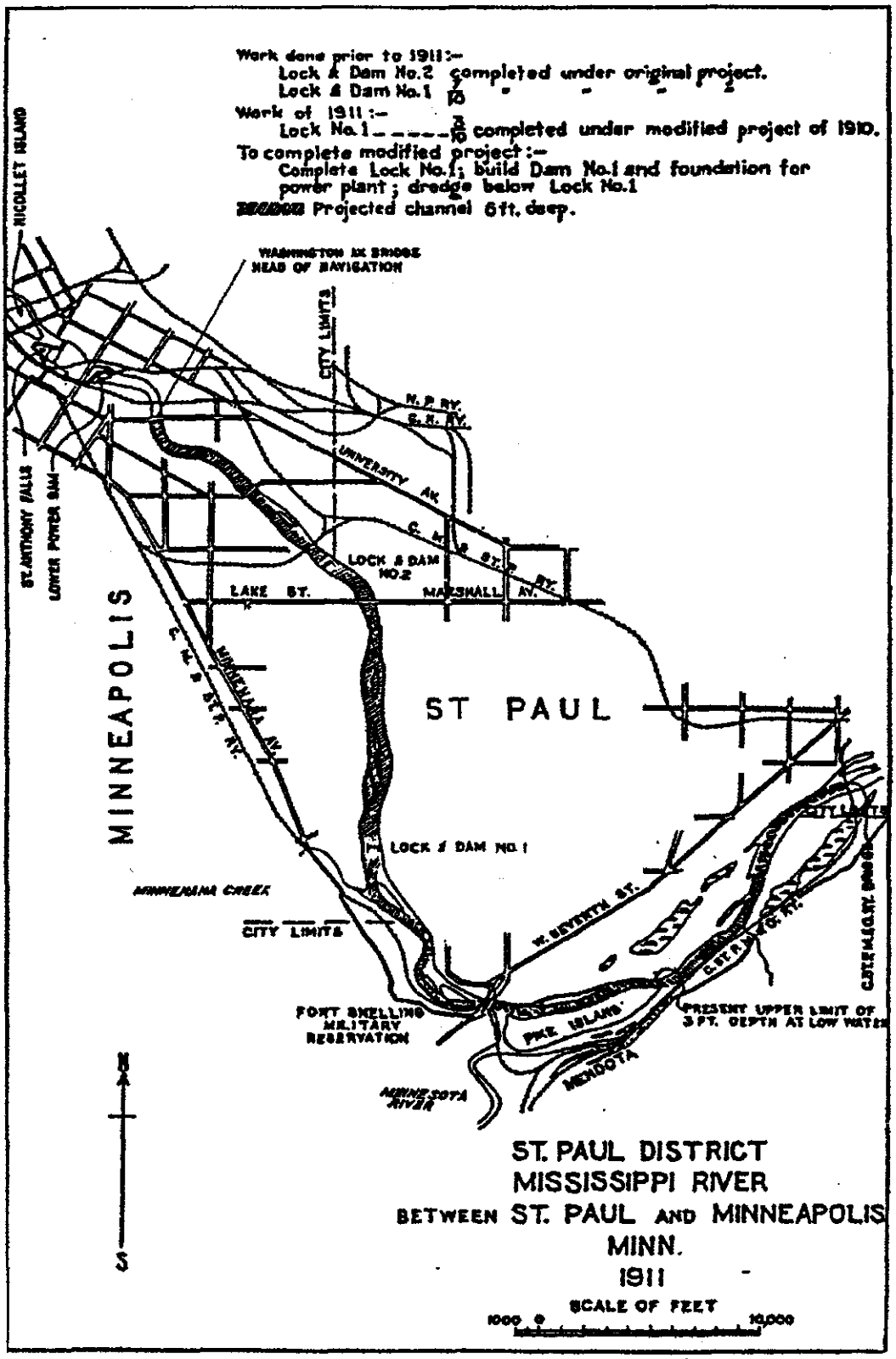
[8]Ibid., pp. 310-11.

[9]Ibid., p. 311.

[10]Raymond Merritt *Creativity, Conflict and Controversy: A History of the St. Paul District, U.S. Army Corps of Engineers*, (Washington: U.S. Government Printing Office, 1979), p. 140; Kane, *St. Anthony*, p. 92; "Rivalry," p. 311.

[11]Kane, *St. Anthony*, p. 93.

[12]Ibid., pp. 92-93.



(Adapted from Annual Report of the Chief of Engineers, St. Paul District Report, 1911.)

Ft. Snelling. Cadwallader C. Washburn and his brother William D., two of the city's most powerful and prominent millers, owned the Minneapolis Mill Company and adamantly opposed locks and dams. Cook completed his survey between 1866 and 1867. As he had worked for the millers against the project, Meeker expected a negative report. To Meeker's surprise, Cook recommended that a lock and dam be constructed at Meeker Island, which would provide a 13-foot lift. Warren endorsed Cook's plan and requested $235,665 for the project.[13] With Cook's favorable report before it and with the support of Representative Donnelly and Minnesota Senator Alexander Ramsey, Congress gave the State of Minnesota a 200,000 acre land grant. In arguing for the grant, Minnesota claimed that navigation was the principal purpose and that hydropower was "incidental." Reflecting the position of Minneapolis, the State pointed out that, given the extensive hydropower at the falls, creating more hydropower would be superfluous.[14] Minneapolis celebrated the grant. On June 7, 1868, the Minneapolis Daily Tribune claimed that the Meeker Island lock and dam would "transfer the commercial prestige of this upper country from St. Paul to the 'Magnet.'"[15] St. Paul also rejoiced. A day earlier, the St. Paul Daily Dispatch had declared that the dam had given St. Paul "a water power equal to St. Anthony," and would provide enough power "to make St. Paul one of the largest manufacturing cities on the continent."[16] Through a deal between Meeker and a number of St. Paul businessmen, St. Paul had gained control of Meeker's company and would get the

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[13]U.S. Army, Corps of Engineers, *Annual Reports of the Chief of Engineers*, 1867, (Washington, D.C.: Government Printing Office, 1866-1930), pp. 259, 262; hereafter *Annual Report*; River and Harbor Act of June 23, 1866, *Laws of the United States Relating to the Improvement of Rivers and Harbors*, vol. 1, House of Representatives, House Doc. No. 1491, 62d Cong. 3d sess., (Washington: Government Printing Office, 1913), pp. 155-56; U.S. Congress, House, "Survey of the Upper Mississippi River," Executive Document 58, 39th Congress, 2d Session, pp. 30, 50-52. In his next report to the Chief of Engineers, Warren stated that new surveys showed that the Corps would have to build a second lock and dam, locating it near the mouth of Minnehaha Creek, about one-half mile below Lock and Dam No. 1. See U.S. Congress, House, "Survey of the Upper Mississippi River," Executive Document 247, 40th Congress, 2d Session, p. 9.

[14]House Executive Document 58, pp. 45-46.

[15]Kane, "Rivalry," pp. 312-314, quote from p. 315; Kane, *St. Anthony*, p. 94.

[16]Kane, "Rivalry," p. 316.

waterpower created by the dam, even if Minneapolis and the State thought it unnecessary.[17]

Resolving the political problems raised by placing locks and dams between the cities would prove more complex than the engineering solution. Proponents and antagonists divided along city lines and by economic interest. Millers at St. Anthony Falls, like the Washburns, generally opposed the project, as it would create a competing waterpower below them. Yet, one of the project's key proponents--Morrison--came from their ranks. Shippers and civic boosters in Minneapolis wanted locks and dams to make the city the head of navigation to secure the lower shipping rates and the prestige that went with the position. Lumbermen sided with the millers because they wanted the river left open for the floating of logs to booms above St Paul. In St. Paul, business and civic boosters believed that a dam would deliver hydropower to their city, allowing it to develop milling and manufacturing as Minneapolis had so successfully done. Other St. Paul business and civic boosters feared a lock and dam would steal the city's place as the head of navigation. With formidable supporters arrayed for and against the project--supporters who believed that the conditions that defined their success were at stake--the proposal to build locks and dams became mired in an intense intercity rivalry.[18]

On March 6, 1869, the State gave the land grant to Meeker's company. It required the company to spend $25,000 on the project before February 1, 1871, and to complete it within two years. If the company failed in either requirement, the State threatened to rescind the grant and reissue it to another company. Having accomplished nothing as the deadline approached, the Mississippi River Improvement and Manufacturing Company spent $26,000 during late 1870 and early 1871 to avoid losing the grant. It did not begin working on the project, however, focusing instead on a provision in the grant that limited the company to selling no more than one section of land within a township. As this requirement had proved cumbersome, the company asked Congress to modify it, allowing the sale of more sections within a single township. To

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[17]Ibid. The St. Paul businessmen included William E. McNair, Eugene M. Wilson, William S. King, Edward Murphy, and Isaac Atwater.

[18]Kane, "Rivalry," pp. 309-23; Merritt, *Creativity*, p. 140, contends that "Nowhere can the rivalry between Minneapolis and St. Paul be better illustrated than in the controversy over the proposal to build a lock and dam about two miles below the Washington Avenue Bridge at Meeker Island." Kane, "Rivalry," p. 313, says that the Washburn's, according to Meeker, worried that "another water power . . . might *incidentally*" arise from the effort to get boats to St. Anthony Falls.

secure their objective, the company needed support from Minneapolis, and for that support, Minneapolis won back control of the company. At this point, Minneapolis business interests began fighting among themselves over the project.[19]

Project opponents--the millers and boom company operators, especially--offered their now standard arguments against a competing water power so close to the falls, adding that the project might jeopardize Federal funding for repair work at St. Anthony. Sawmill owners also feared that they would not be able to continue dumping sawdust into the river. Some opponents argued that it was the Federal government's responsibility to extend navigation, not private interests subsidized by the government. During its 1872-1873 session, Congress defeated the bill to amend the land grant and debate over the project subsided.[20]

As Meeker failed to build the lock and dam, Congress appropriated $25,000 for the Corps to undertake the project, in 1873.[21] Congress, however, required that the State return the land grant before the Corps could begin work. Eager to start the project, Major Francis Farquhar, the new head of the Corps' St. Paul office, reported, in 1873, that he had initiated a survey of the river and of the dam site. Over the next year, he began developing plans, determining that the Engineers would build one lock and dam. Further work on the project, he declared, had to wait until the Engineers could take borings, and they could not do this until the State returned the land grant. As the State failed to return the grant, the Corps refused to begin work. Nevertheless, Farquhar optimistically asked for $300,000 for the

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[19]Kane, "Rivalry," pp. 318-319. Opponents to the amendment included William D. Washburn and Chute. It also included sawmill operators and boom company operators William W. Eastman, John Martin, Sumner W. Farnham, James A. Lovejoy, and Joel B. Bassett. Support came from the company's stockholders, navigation boosters and city business leaders. See p. 319.

[20]Kane, "Rivalry," pp. 319-320; Kane, *St. Anthony*, p. 96. In 1869, a tunnel from the toe of the fall to Nicollet Island collapsed just below the island. Due to the collapse of the Eastman tunnel, the falls were in danger of being eroded away. The Corps of Engineers was working on a project to save the falls.

[21]Kane, "Rivalry," p. 322, suggests that the Federal government recognized its obligation for improving navigation in 1873 by authorizing $25,000 for the project. Merritt, *Creativity*, p. 141, says that "When it appeared that the Mississippi River Improvement and Manufacturing Company would not be able to resolve its internal conflicts, Congress decided to give the project over to the Corps of Engineers." Neither author discusses who pushed Congress to authorize the project.

fiscal year ending June 30, 1876.[22] Disagreement over the grant and haggling over land for the project, including the purchase of Meeker Island, however, would delay the project for nearly twenty years.[23]

Despite the land grant problem, Congress authorized another survey of the river between St. Paul and St. Anthony Falls on August 5, 1886. The St. Paul District submitted its report of survey to the Chief of Engineers on December 29, 1887, and the government printed it as House Executive Document No. 158. In this document, the Corps called for two locks and dams to bring steamboats to the Washington Avenue bridge, 2.2 miles above Meeker Island, and a third to extend commerce to the 10th Avenue Bridge, just below the falls.[24] Congress, however, did not act upon the report.

With the lock and dam project on hold, the Corps began considering other ways to improve the river between Minneapolis and St. Paul. In the 1888 River and Harbor Act, Congress had authorized the Engineers to work on this but did not specify what work the Engineers were to do. In 1890, the Corps used some of the funding to survey the Meeker Island or the "rocky, rapid portion" of the river.[25] A proposal to build a dam in this area by Thomas Lowry, a Minneapolis businessman who controlled the Minneapolis Street Railway Company, had spurred the Corps to undertake this survey. Lowry thought he might be able to use the Meeker Island site to generate power for his street cars in Minneapolis and St. Paul. Henry Villard, a New York financier and railroad promoter interested in street railway systems, joined Lowry in exploring the possibility of a dam and plant at Meeker Island. A Villard

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[22]*Annual Report*, 1873, p. 411; Ibid., 1874, p. 287.

[23]Merritt, *Creativity*, p. 141.

[24]*Annual Report*, 1887, p. 1663. No evidence that I have uncovered demonstrates that the rivalry between St. Paul and Minneapolis led the Corps to propose two dams in this report. *Annual Report*, 1888, pp. 1536-39. In 1888, Rock Island District assumed jurisdiction of this reach of the river. Kane jumps to the construction of Lock and Dam No. 2, without explaining how the impasse over the land grant was resolved or who made the final push for the project. In *St. Anthony*, p. 175, she simply says, "Deprived of the navigation facilities they coveted, persuasive Minneapolitans continued to urge the federal government to act. United States army engineers responded in 1894 by announcing plans for two locks and dams . . . ." The Corps was in no position to respond to pleas from Minneapolis. I have not yet learned how the Congress resolved the land grant issue in authorizing the project in 1894.

[25]*Annual Report*, 1890, p. 2034.

representative and a Corps engineer undertook the survey. They concluded that the Meeker Island site was not the best and that the dam should be located further downstream, placing it well within the St. Paul city limits.[26] Their recommendations disrupted relations between Minneapolis and St. Paul, which had been temporarily good. Minneapolis protested that "it would be a 'perfect absurdity' to support a scheme giving so substantial a resource to its neighbor."[27]

The Pillsbury-Washburn Company also objected to Villard's and Lowry's plans. Pillsbury-Washburn hoped to build a dam and hydroelectric plant just below the falls and charged that a dam at Meeker Island or at any point above downtown St. Paul would back water up to their site and limit its hydropower capacity. William De la Barre, the company's engineer and the chief architect of water power development at St. Anthony Falls, notified Villard and Lowry that they would need to buy the riparian rights from the Pillsbury-Washburn Company for land flooded by their dam. De la Barre warned them that the Pillsbury-Washburn Company would defend its rights, if Villard and Lowry pursued their project. This warning and the cost of purchasing the flowage rights forced Villard and Lowry to abandon their scheme.[28]

Lowry secured his hydroelectric power, anyway. Carrying through on their plans, De la Barre and the Pillsbury-Washburn Company built their new dam and hydroelectric station below St. Anthony Falls between 1895 and 1897. Reflecting the attitude of its owners toward navigation, the dam did not include a lock. Designed by De la Barre and capable of generating 10,000 horsepower, Pillsbury-Washburn leased the electricity to Lowry for his streetcar company.[29]

On April 29, 1890, the Corps again surveyed the river, this time to determine if they could make it navigable by removing boulders and rocks.[30] Major Alexander Mackenzie, the Rock Island District Engineer who had taken over the project in 1888, wanted to locate and examine the boulders in case Congress authorized the Corps to remove them in lieu of building locks and dams. Mackenzie

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[26]Kane, *St. Anthony Falls*, pp. 152-53.

[27]Ibid., p. 153.

[28]Ibid., pp. 153-54.

[29]Ibid., p. 154.

[30]*Annual Report*, 1891, p. 2154; Mackenzie, Ibid., 1890, p. 2034, reported that the Corps had completed several examinations of the area over the last year, "in company with the Minneapolis representatives of the river interests."

questioned the value of this work, however, believing that the current was too rapid to allow navigation to the falls without locks and dams.[31] As Mackenzie suspected, Congress provided $50,000 to the Corps for removing boulders, which the Engineers began doing in 1890 and 1891.[32] In 1892, Mackenzie again insisted that locks and dams were necessary to bring steamboats above Meeker Island and any other efforts wasted time and money.[33]

Signaling a change, the Chief of Engineers, on February 15, 1893, directed Mackenzie "to prepare new and exact estimates for locks and dams for this portion of the river . . . ." Mackenzie made the surveys, including borings, during the low-water season of 1893 and concluded that the Corps would have to build two locks and dams to bring navigation to the old steamboat landing below the Washington Avenue bridge. Lock and Dam No. 1 would have to be placed above Minnehaha Creek and have a lift of 13.3 feet. Lock and Dam No. 2 could then be placed about 1,000 feet below the Chicago, Milwaukee and St. Paul Railway bridge, below Meeker Island, and would have a lift of 13.8 feet. Mackenzie added that the Corps would have to build a third lock and dam with a 10.1 foot lift to bring navigation to the lower dam at St. Anthony Falls and a fourth lock to bring navigation to the flour mills. Mackenzie, as had his predecessors, suggested that the lock dimensions should be 80 feet by 334 feet, the dimensions of the Des Moines Rapids canal locks, which the Corps had opened in 1877. He estimated that Lock and Dam No. 1 would cost $568,222 and that Lock and Dam No. 2 would cost $598,235. Extending navigation above St. Anthony Falls with the other two locks and dams would total $1,538,702.[34]

Accepting Mackenzie's arguments and under continual pressure by navigation proponents in Minneapolis, Congress authorized the

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[31]Ibid., 1890, p. 2034.

[32]Ibid., 1892, pp. 1780-81. The Engineers had been using a steamdrill and derrick boats to remove rock between St. Anthony Falls and Meeker Island. See Ibid., 1893, p. 2212.

[33]Ibid., 1893, p. 2202. In June and July of 1891 Mackenzie carried out even more "accurate surveys" of most of the river from the Minneapolis steamboat warehouse to the Short Line bridge below Meeker Island, and of select areas down to the Minnesota River. See Ibid., 1891, p. 2154.

[34]Ibid., 1894, pp. 1682-83; U.S. Congress, Senate, *Construction of Locks and Dams in the Mississippi River*, 53d Cong., 2d Sess., S. Exec. Doc. No. 109, pp. 7-8. I have discovered no evidence that Mackenzie suggested multiple dams based on the rivalry between Minneapolis and St. Paul. The location and height of the dams in this report is very similar to that originally proposed by Brevet Major General Warren in 1867 and 1868 and by other Engineers thereafter.

"Five-Foot Project in Aid of Navigation," in the River and Harbor Act of August 18, 1894. In this act, Congress authorized the Corps to extend navigation to the Washington Avenue bridge by constructing Lock and Dam No. 2.[35] While it did not mention Lock and Dam No. 1, Congress called for improving the river from near the mouth of the Minnesota River to the Washington Avenue bridge, indicating that another lock and dam would be built below Meeker Island. Following through on the 1894 act, Congress provided for the construction of Lock and Dam No. 1 in the River and Harbor Act of March 3, 1899.[36] By the fall of 1906 the Engineers had completed most of Lock and Dam No. 2 and on May 19, 1907, the Itura became the first steamboat to pass through the lock. At Lock and Dam No. 1, the Engineers had begun constructing the lock.[37] Soon, Minneapolis would be able to claim title to the head of navigation.

IV. A NEW MILIEU

A. Hydropower Power Possibilities

While the Spring of 1907 brought the goal of Minneapolis navigation boosters closer to fruition, other events, already underway, would soon lead the Corps to demolish Lock and Dam No. 2. In the River and Harbor Act of June 25, 1906, Congress created a commission to examine the hydropower potential of the river between Minneapolis and St. Paul. The commissioners--Major W. V. Judson from the Corps of Engineers, J. E. Woodwell from the Treasury Department, and Major Amos W. Kimball from the Quartermaster Corps--held a preliminary meeting in St. Paul on March 28, 1907, to study data in the St. Paul District office and visit the locks and dams. They did not meet again until September 26, when they completed

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[35]River and Harbor Act of August 18, 1894, *Laws of the United States Relating to the Improvement of Rivers and Harbors*, vol. 2, U.S. Congress, House, 62d Cong., 3d Sess., S. Doc. No. 1491, (Washington: U.S. Government Printing Office, 1940), p. 704. Kane, *St. Anthony*, p. 175, says that the Corps of Engineers responded to influential businessmen in Minneapolis by announcing plans for two locks and dams. This misplaces the authority for authorizing the project with the Corps instead of Congress and makes the Corps a proactive proponent of the project, which she does not demonstrate they were. Furthermore, Congress only mentions Lock and Dam No. 2 in the 1894 act. At this point, I have no evidence as to what led Congress to include the 5-foot channel project in the 1894 Rivers and Harbors Act.

[36]*Annual Report*, 1908, p. 530.

[37]Ibid., 1907, pp. 1578, 1579; Ibid., 1908, pp. 1649-50.

their report and forwarded it to the Chief of Engineers, Brigadier General Alexander Mackenzie.[38]

The commissioners determined that the low head, or short fall, at Lock and Dam No. 1, would not permit the economic development of hydroelectric power. While the head at this site varied from 10.2 feet at low-water to 4.0 feet at high stages, the high stages lasted longer than usual, due to the Minnesota River, which entered the Mississippi about two miles downstream and backed water up to Lock and Dam No. 1. Consequently, "The real problem," the commissioners decided, was "to determine what power, if any, can be economically developed at Dam No. 2."[39] Here also, they concluded, water power development would not be worthwhile. Like its counterpart downstream, Lock and Dam No. 2 had a low head, but it had more serious problems. The commissioners feared that the sandstone river bed might not be solid enough for the low dam, much less a high dam. Someday, they speculated, higher energy costs and demand from the growing population of the Twin Cities would make the power gained from low-head dams more valuable. Then, the hydropower at the two sites would be worth capturing. Twenty to 25 years in the future, they speculated, the cities could even consider building a single high dam downstream of Lock and Dam No. 1.[40]

Interest in developing hydroelectric power at the locks and dams did not fade with the commission's report. Just before the commission held its first meeting, Congress changed a major premise that the study did not consider. In the March 2, 1907, River and Harbor Act, Congress authorized a 6-foot channel for the Upper Mississippi River from St. Paul to the mouth of the Missouri River. As Locks and Dams 1 and 2 had been designed for a 5-foot channel, the Engineers had to reconsider the design of each. Whatever they decided, the cost of the original project would increase. Now the expense of starting over could be compared to the cost of modifying the structures. And as the dams would have to be one-foot higher,

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[38]U.S. Congress, House, *Use of Surplus Water Flowing over Government Dam in Mississippi River between St. Paul and Minneapolis, Minn.*, 60th Congress, 1st Sess., H. Doc. No. 218, pp. 2, 6. A key issue that I have had not had time to research is why Congress authorized this study in 1906. Who pushed Congress to authorize it? Why would Congress even consider revamping a project that was more than 50% complete? Mackenzie, after serving as the Rock Island District Engineer from 1879 to 1895, became the Chief of Engineers on January 23, 1904.

[39]Ibid., p. 3.

[40]Ibid., pp. 4-6.

their hydropower potential would increase.[41] Pressure also mounted for a high dam to realize the maximum hydropower from the river. Consequently, in the River and Harbor Act of March 3, 1909, Congress authorized the Corps to reexamine the projects' hydropower potential. Pending the outcome of this study, the Corps suspended work on Lock and Dam No. 1, in the spring of 1909. As of June 30, the Corps had spent $1,149,453 on the two locks and dams.[42]

To undertake the new study, the Corps appointed a board of engineers that included Majors Charles S. Riche, Francis R. Shunk and Charles Bromwell. The board considered two issues. First, they evaluated whether the Corps could easily and cheaply adapt the 5-foot project to the 6-foot project. Second, they reassessed the hydropower capacity of the river between Minneapolis and St. Paul. The board examined the navigation issue first and quickly concluded that, with minor changes, the existing project would provide an adequate 6-foot channel.[43]

Developing hydropower raised more difficult concerns. The board determined that it would not be worthwhile to generate power at the two low dams, even with the additional foot of height created by the 6-foot channel project. To capture the power, the Corps would have to build a high dam. The only feasible site for this dam would be at Lock and Dam No. 1. To place it further upstream would require a lower dam because of the new hydroelectric station and dam at Lower St. Anthony Falls. To build it further downstream would flood the Minnehaha Creek gorge, which, the board noted, was "one of the natural attractions of the city of

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[41]Merritt, *Creativity*, p. 142. Merritt argues that Minneapolis and St. Paul officials haggled over the placement of Lock and Dam No. 1 and that high water hampered its start. "Business interests in Minneapolis and St. Paul," he contends, "used the delay to press for a larger dam that would generate electrical power." Responding to these interests, Congress established a special commission to reassess the project.

[42]River and Harbor Act of March 3, 1909, *Laws of the United States*, vol. 2, p. 1343; *Annual Report*, 1909, p. 561.

[43]U.S. Congress, House, *Mississippi River, St. Paul to Minneapolis, Minn.*, 61st Cong., 2d Sess., H. Doc. 741, p. 5. The board proposed using flashboards--wooden boards attached to the dam's surface--to raise the height of Dam No. 2 to provide for a 6-foot channel. At Lock and Dam No. 1, they proposed raising the height of the dam by one-foot and adding an auxiliary lock below Lock and Dam No. 1 for extreme low-water situations. The Board of Engineers for Rivers and Harbors concurred with the first recommendation but disagreed with the second. Rather than building another lock, it suggested that the Corps lower the already completed floor by the necessary depth. See pp. 5, 14.

Minneapolis."[44] By replacing Dam No. 1 with a 30-foot high dam, the Engineers estimated that they could 15,000 horsepower.[45]

To construct the new dam, the board considered the Corps building it alone or in partnership with a private or municipal party. The board determined that the Corps could not built a high dam alone, because to do so would be solely to capture the hydropower. If the Engineers built the project alone, they would have to justify it entirely for navigation. The board noted that a single lock and dam would save operating and maintenance costs, would require only one lockage, and in providing a 9-foot depth would not require any modifications authorized by future navigation projects. They suggested that the Corps could use the rent gained from the hydropower of a single dam to construct and operate the lock and dam, and the Federal government would have an endless surplus of power. If the Corps had not completed Lock and Dam No. 2 already, the board stated, it could easily have recommended one lock and dam to be built by the government. But, as the board had already determined that the two low dams would secure the depth needed for navigation, they recommended that some other party pay the extra cost of building the new high dam.[46]

On the morning of June 9, 1909, the board held a public hearing in St. Paul to determine what assistance the government could expect from municipal or private interests if it decided to build a high dam. Representatives from St. Paul and Minneapolis attended the meeting and strongly favored a high dam. To their surprise, the State of Minnesota also declared an interest in the project and the hydroelectric power it would generate. To their dismay, private companies also attended the meeting and backed the high dam.[47]

Interest by private companies in the high dam frightened the cities, and became a key issue at the meeting. The Corps fueled worry over private development. Board member Major Shunk, the St. Paul District commander, told representatives from the cities that the board "would listen to proposals from outside interests to pay all extra cost necessary to raise the dam to such a height as would

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[44]Ibid., pp. 5-6.

[45]Ibid., p. 6.

[46]Ibid., pp. 6-7.

[47]*Minneapolis Tribune*, June 9, 1909, p. 1; House Doc. 741, p. 5. Representatives from the University of Minnesota had met a party from St. Paul and Minneapolis at Lock and Dam No. 1 the day before. At this encounter, the two cities learned of the University's interest in the hydroelectric power of high dam.

produce desired power."[48] Hoping to get the hydropower generated by a high dam cheaply, city and State representatives feared that the government would start a bidding war, and they "bitterly denounced" the "attitude of the government in permitting such a prospect. . . ."[49]

Encouraged by the Corps position, private interests had attended the public meeting. A. W. Leonard, manager of the Minneapolis General Electric company, reported that his firm could have a proposal ready in 60 days and would pay the government more than the extra cost of constructing a high dam.[50] Paul Doty, representing the St. Paul Gas Light Company, argued that a private enterprise could develop the water power better than the State or the municipalities.[51] In response, representatives from the cities argued that the Federal government should favor them, and that the water power was a natural resource that belonged to cities and the State. They asked the board to give them time to prepare a proposal, which would take much more than 60 days.[52]

Following the morning session, Minneapolis, St. Paul and the State met to discuss a strategy for developing the river's hydropower potential. They formed a nine-person commission, with three members from each party, to prepare a proposal to share in building a high dam. Due to constitutional requirements, however, they could not offer a definite proposal until after the next legislative session in two years.[53] The State constitution prohibited the State from issuing the bonds needed to build the project, and the city charters of Minneapolis and St. Paul barred them from making expenditures for such purposes.[54] While the State's ability to amend its constitution was in doubt, both cities planned to amend their charters. The board, in submitting their report to the Chief of Engineers, noted that "it is the opinion of the mayors of the two cities, of representatives of the city councils, and of all the representative citizens who spoke at the hearing that there will be no difficulty in obtaining legislative

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[48]*The Minneapolis Tribune*, June 9, 1909, p. 1.

[49]*St. Paul Pioneer Press*, June 10, 1909, p. 4.

[50]*Minneapolis Tribune*, June 10, 1909, p. 2.

[51]*St. Paul Pioneer Press*, June 10, 1909, p. 4.

[52]*Minneapolis Tribune*, June 10, 1909, p.2; H. Doc. 741, p. 5.

[53]Ibid.; *St. Paul Pioneer Press*, June 10, 1909, p. 4.

[54]Kane, "Rivalry," p. 321.

action modifying the charters at the next session of the State legislature."[55] Both cities passed resolutions favoring the project.[56]

After evaluating their options, the board dismissed working with a private company. It based this decision on the reaction of Minneapolis and St. Paul to private development. The board believed it "abundantly evident" that the two cities, which owned much of the land above the dam site, would not relinquish it to a private company. Proposing to work with a private company, it concluded, "would be equivalent to recommending against a high dam . . . ."[57] The two cities, the board reported, would rather see the power go to waste than let a private company develop it.[58]

Having eliminated construction by the Federal government alone or in cooperation with a private company, the board determined that working with the Twin Cities to build the new high dam would be the best alternative. The board believed that the city charters would be changed, due to the strong support received from the citizens and governments of the two cities. In a dramatic turnabout, the cities agreed to split the cost of building the new structure and to share the hydropower. Minneapolis even agreed to advance St. Paul's share.[59] Thus, the board recommended that Congress modify the navigation project to raise Dam No. 1 to 30 feet, in collaboration with Minneapolis and St. Paul.[60]

While the new Chief of Engineers, W. L. Marshall, endorsed the board's recommendations, he made an important change. Rather than working with a municipality to fund and build the new high dam, he urged Congress to fund the entire project. The "construction of such a lock and dam by the Government is feasible, practicable, and

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[55]H. Doc., 741, p. 8.

[56]Ibid., pp. 8-9.

[57]Ibid., p. 7.

[58]Ibid., p. 8. In contrast to this position by the board, the *Minneapolis Tribune*, June 10, 1909, p. 4, reported that those present at the June 9 public meeting voted to go on record as favoring the building of the high dam, whether accomplished by the State, the cities or a private interest.

[59]House Doc. 741, pp. 8-9. The board eliminated the State of Minnesota from consideration because it believed that the State's constitution was not likely to be amended to allow it to engage in such a project. The Minneapolis resolution included hydropower for the University of Minnesota.

[60]Ibid., pp. 12-13.

legal under existing conditions," he insisted.[61] Sharing the construction costs with a nonFederal partner, he warned, had proven "conducive to friction and misunderstanding, and often attended serious complications . . . ." If the government paid the full construction cost, he argued, then it would have complete control of the waterpower produced.[62]

Marshall bolstered his position with other arguments. Even though the Engineers had completed Lock and Dam No. 2 and had finished much of Lock No. 1, he suggested that Congress might authorize a deeper project in the near future. The high dam would easily accommodate a project of seven, eight or nine feet. While it would cost $230,000 or more to build the new structure, he contended that the hydroelectric power generated at the new dam would pay this cost and supply power to other Federal offices in the Twin Cities. Once the Engineers had built the power station, the government, he proposed, could run it or lease it to a private company or municipality.[63]

Although it did not show in the board's report, at least one of its members agreed with the Chief of Engineers. Major Shunk believed that Congress should authorize the Corps to build a high dam for navigation and to add a power plant to it. In a move that historian Raymond Merritt calls uncharacteristic for a Corps representative, Shunk tried to convince businessmen in the Twin Cities to support the project. Like other high dam proponents, Shunk argued that it would be easier to operate, save time, and could pay for itself with the power generated. He hoped that if the Twin Cities demonstrated enough demand for the project Congress

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[61]Ibid., p. 3.

[62]Ibid., pp. 3-4. Samuel P. Hays, *Conservation and the Gospel of Efficiency: The Progressive Conservation Movement, 1890-1920*, (Cambridge, Massachusetts: Harvard University Press, 1959), p. 114, presents information that would explain Marshall's decision. Hays relates that when some members of the Inland Waterways Commission suggested that private parties pay the cost of the hydropower portion of a navigation dam, "the Corps of Engineers and many in Congress objected that this would give rise to conflicts in operation and administration . . . ." As a result, Hays says, the commission decided that the Federal government would pay the construction costs and lease the power. The question at Lock and Dam No. 1 was not simply whether the government would pay all or part of the cost to make hydroelectric power possible. That fact that the Engineers had completed much of the authorized navigation project put the Corps in the position of redoing the project specifically to accommodate hydropower development. See Hays, pp. 109 and 215, for General Mackenzie's position on this issue.

[63]Ibid., p. 3.

would authorize it. In a letter to Minneapolis Mayor James C. Haynes, Shunk contended "that the whole issue was not a legal concern, but a moral matter."[64] He could not accept allowing the water power to go to waste. Officially, however, Shunk supported the position that the Federal government only had the authority to regulate navigation and not to build or regulate hydroelectric power plants.[65]

On January 31, 1910, the board submitted its report to the Chief of Engineers. Following the Corps' recommendations, Congress called for a high dam in the 1910 River and Harbor Act, "Provided, That in the making of leases for water power a reasonable compensation shall be secured to the United States . . . ."[66]

The St. Paul District completed Lock and Dam 1 in 1917. As provided for in the 1912 River and Harbor Act, the Engineers built the foundation for a hydroelectric power plant but did not build the plant. Section 12 of this act had given the Secretary of War, based upon the opinion of the Chief of Engineers, the authority to "provide in the permanent parts of any dam authorized at any time by Congress for the improvement of navigation such foundations, sluices, and other works, as may be considered desirable for the future development of its water power."[67] It did not allow the government to develop the water power itself, however. Entangled in the debate over the Federal government's role in hydroelectric power development, the power station base remained unused for more than six years.

To ensure safe navigation above the new dam, the Engineers demolished the top five feet of Dam No. 2, in 1912. The riverward lock wall still remains in the river, visible for most of the year. While historians point to the old lock wall as a monument to the rivalry between Minneapolis and St. Paul, it is much more than

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[64]Merritt, *Creativity*, p. 144; Merritt, p. 145, adds that while Shunk recognized that the Corps of Engineers had no authority to develop hydropower, he believed that this "was just a case of legislative oversight . . . ." Given the debate over the government's role in hydroelectric power development, which I discuss below, it was not simply a matter of legislative oversight.

[65]Ibid., *Creativity*, pp. 144-45.

[66]River and Harbor Act, June 25, 1910, *Laws of the United States*, vol. 2, pp. 1419-20; *Annual Report*, 1910, pp. 1799-1800.

[67]River and Harbor Act, July 25, 1912, *Laws of the United States*, vol. 2, pp. 1564-65.

this.[68] It and Lock and Dam No. 1 are a testament to much larger debates and trends in American history.

In an era when conservation became a fad, destroying a new lock and dam seemed an unconscionable waste. Many people questioned why Congress had authorized two dams rather than one and tried to place blame on one party or another. In a 1910 University of Minnesota thesis on developing the hydroelectric potential of the river at Lock and Dam No. 1, George W. Jevne and William D. Timperley contended that Congress rejected the first bill for a high dam, in 1894, "on the grounds that power development was beyond the scope of the project--waterway improvement."[69] In another thesis on the same subject completed one year earlier, three University of Minnesota engineering students contended that the Corps' Board of Engineers had reported adversely on the single dam proposal because "it would not be possible for the United States to stand the expense of such a dam when it was not entirely necessary for the improvement of navigation."[70] They also blamed the two dam project on the rivalry between Minneapolis and St. Paul. Major Shunk also faulted intercity politics. In a letter to Minneapolis Mayor James C. Haynes in 1909, he explained that Congress had adopted a 5-foot channel based on the best information it had at the time and that he did not believe that "any advisory board which might have assembled fifteen years ago would have recommended a greater depth." Concerning the building of two dams to achieve this depth, he wrote: "Now, as to the duplication of locks and dams; two instead of one . . . . no officer of the corps of engineers has ever been in favor of these two locks. They were brought about by local influence . . . . such things happen in

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[68]Merritt, *Creativity*, p. 143; Kane, "Rivalry," p. 322.

[69]George W. Jevne, and William D. Timperley, "Study of Proposed Water Power Development at U.S. Lock and Dam No. 1, Mississippi River Between St. Paul and Minneapolis," (Thesis, University of Minnesota, 1910), p. 1; Jon Gjerde, *Historical Resources Evaluation, St. Paul District Locks and Dams on the Mississippi River and Two Structures at St. Anthony Falls*, unpublished, for St. Paul District, Corps of Engineers (September 1983), p. 84.

[70]Walter C. Beckjord, Ralph M. Davies, Lester H. Gatsby, "A Study of Proposed Water Power Davalopment at U. S. Lock and Dam No. 1, Mississippi River between St. Paul and Minneapolis," (Thesis, University of Minnesota, 1909), pp 1-2. This thesis and the previous one by Jevne and Beckjord were writtan as the University of Minnesota was considering how it might use the hydroelectric power generated at a high dam.

countries where people have votes."[71] These issues--the rivalry between the cities and the attitude of the Corps and Congress toward hydroelectric power development--explain in part why Congress authorized two dams instead of one, but other issues contributed.

B. National Waterway Development

The national perception of waterway development changed during the first two decades of the 20th century. By the early 1900s, key government officials, including President Theodore Roosevelt supported waterway development. Before this time, few Presidents had promoted Federal spending on waterway projects, and none had done it so ardently. Waterway supporters had two primary concerns. First, they wanted to develop America's waterways to the fullest extent to support transportation. Second, they called for using waterways for multiple purposes: hydropower, flood control and recreation, as well as navigation. These conservationists generally ignored fish and wildlife conservation. Gifford Pinchot--national forester under Roosevelt and key architect of the government's conservation crusade--and other leaders of the movement saw little economic value in managing resources for fish and wildlife or in preserving places for their aesthetic value. The Corps and the House Rivers and Harbors Committee would become the major restraints on navigation projects and the multiple-purpose approach.[72]

Historian Samuel Hays, who has written one of the most important studies of the debate over water resources, says that during latter years of the nineteenth century and early years of

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[71]Major Francis R. Shunk to the Honorable J. C. Haynes, Mayor of Minneapolis, February 17, 1909, St. Paul District Records, St. Paul, Minnesota. The Corps had been proposing two dams since Warren recommended a second dam in U.S. Congress, House, "Survey of the Upper Mississippi River," Executive Document 247, 40th Congress, 2d Session, p. 9, in 1868. Kane, "Rivalry," p. 322, criticizad the Corps for tha construction of two dams. "The lock and dam built near Meeker Island proved to be an embarrassment to the government--a 'shocking blunder' some called it." This "blunder," she says, "weighad heavily on the minds of the anginears responsible for the decision."

[72]Edward L. Pross, "A History of Rivers and Harbors Appropriations Bills," (Ph.D. dissertation, Ohio State University, 1938), p. 142; Isaac Lippincott, "A History of River Improvement," *Journal of Political Economy* 22 (Chicago: University of Chicago Press, 1914):630-60; Donald C. Swain, *Federal Conservation Policy, 1921-1933*, (Berkeley and Los Angeles: University of California Press, 1963), p. 32.

the twentieth century the United States "witnessed a new enthusiasm for the improvement of its navigable streams. Communities throughout the country seemed to catch a vision of the unlimited possibilities for local economic growth which cheaper transportation could create."[73] Cheap transportation had become an issue during the late nineteenth century as railroad rates, which had fallen during the previous decades, began rising.[74] The Mississippi River, while carrying great quantities of timber for the last three decades of the nineteenth century, supported little commercial freight during this period. Railroads had taken this traffic away by the 1880s. By 1900, timber shipping on the Mississippi River had peaked, and soon the river would carry no significant commerce. The river's decline as a transportation route surprised many Midwesterners, who had assumed that it would always serve this role. They argued that the government should restore the river to its rightful position; with this accomplished, they asserted, the river would regulate railroad rates.

Strongly supported by urban merchants and manufacturers, shippers fought for legislation to strengthen the Interstate Commerce Commission's power to regulate railroad rates and to promote inland navigation projects. Public support for waterway improvement grew rapidly during the early years of the twentieth century. "The interests of merchants and manufacturers," Hays contends, "soon became merged with the larger interests of the entire community, as local and regional waterway publicity groups and newspaper editors warned that the future growth of the community itself depended on cheaper transportation." Support for waterway improvement became so intense, he says, that it became an issue of local patriotism. Congressmen, perceiving a windfall, eagerly capitalized on this demand.[75]

Evidencing this new interest in waterways, a number of important waterways organizations emerged during the first years of the new century. One called for an intercoastal water route from Boston, Massachusetts, to the Rio Grande. River boosters along the Mississippi River and Illinois Rivers formed the Lakes-to-the-Gulf Deep Water Association to call for a deep channel from Lake Michigan, through the Illinois River, to the Mississippi River. And river boosters from St. Louis to the Twin Cities established the Upper Mississippi River Improvement Association in 1902 to push for a 6-foot channel for the upper river. Created by waterway boosters from around the country in 1901, the National Rivers and

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[73]Hays, *Conservation*, p. 91.

[74]Ibid., p. 92.

[75]Ibid., pp. 91-92.

Harbors Congress unified these efforts. The Rivers and Harbors Congress supported a general program for waterway improvements, backing local and regional projects that it thought merited support.[76]

The House Rivers and Harbors Committee and the Corps, however, steadfastly opposed waterway projects. Representative Theodore E. Burton, who became chair of the Rivers and Harbors Committee in 1899, questioned the economic benefits of most waterway projects. He convinced Congress to create a special board within the Corps to review the feasibility of all new projects. Established in 1902, the Board of Engineers for Rivers and Harbors became a major deterrent to pork barrel projects.[77] The Corps used this board so effectively to restrict the number of projects authorized that it became the focus of angry waterway boosters.[78]

Playing on the national enthusiasm for river improvement, the Upper Mississippi River Improvement Association aroused support for a 6-foot channel project. Congress had authorized a 4½-foot channel in 1878, and the Corps had been trying to achieve it by building wing dams and closing dams and by dredging. Long, narrow piers of rock and brush, wing dams stabbed into the river from the main shoreline or from the bank of an island, constricting the river. Closing dams shut off side channels to focus the river's water down one channel. Navigation boosters believed that this project limited traffic and that a deeper channel would bring commerce back. Surviving scrutiny by the Corps and the Rivers and Harbors Committee, the 6-foot channel became part of the 1907 River and Harbor Act. Below St. Paul, this project required no significant changes in the Corps' river improvement strategy, as it called for more channel constriction. Above St. Paul, it forced the Corps to reassess its plan and added to a growing popular interest in revamping the project.

C. The Conservation Movement

Building on enthusiasm for waterway development, key natural resource leaders in President Theodore Roosevelt's administration advocated a new policy of conservation. By conservation they meant the carefully planned, most efficient use of the country's resources. For waterways, this meant building projects that would

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[76]Ibid., pp. 92-94.

[77]Ibid., p. 93, Hays says that Burton, "more than any other single man ... was responsible for the failure of the multiple-purpose program."

[78]Ibid., pp. 93-94.

capture their hydroelectric potential, prevent flooding, provide recreation and irrigation, and aid navigation.[79] In their focus on efficient use, the conservationists shared the vision of Progressive Era reformers, who sought to make all aspects of business and government more efficient. Tied to this broader movement "the conservation movement . . . became a national fad. Widely publicized, commonly accepted, the concept of conserving natural resources at last entered the mainstream of American thought."[80]

Citizens of Minneapolis and St. Paul, reflecting this national interest in conservation and multiple-purpose planning, recognized that they had missed a tremendous opportunity by pushing for two dams. But they did not change their minds simply because it had become the fad to conserve natural resources. Between 1894, when Congress authorized Lock and Dam No. 2, and 1906, when it authorized the first reevaluation of the project, hydroelectric power came of age. Long distance electric power transmission became feasible about the turn of the century. And while most Americans at the beginning of 1890s viewed hydropower as a curiosity, the opening of the Niagara Falls hydropower plant in 1894 changed this.[81]

Residents of the Twin Cities had observed this transition firsthand. In 1882, the Minnesota Brush Electric Company opened the first hydroelectric power station in the United States at St. Anthony Falls. Although it had a limited generating capacity and few customers ready to employ its power, it heralded the coming of hydroelectric power. Between 1894 and 1895, the Minneapolis General Electric Company built its Main Street Station at St. Anthony, and in 1897, the Pillsbury-Washburn Company completed the Lower St. Anthony Falls dam and hydroelectric plant, providing power to Lowry's Minneapolis Street Railway Company. These projects and long distance power transmission demonstrated the practicality and value of hydroelectricity and allowed the power of

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[79]Swain, *Federal Conservation Policy*, p. 3, 6-7; Hays, *Conservation*, pp. 100-101.

[80]Swain, *Federal Conservation Policy*, p. 3. As an example of multiple-purpose planning, Hays, *Conservation*, pp. 100-01, fittingly uses this example: "Engineering works which tapped a river for one use alone might rule out other uses which could yield even greater benefits. A low dam for navigation, for example, might prevent construction of a higher dam at the same site that would produce hydroelectric power as well."

[81]Philip V. Scarpino, *Great River: An Environmental History of the Upper Mississippi, 1890-1950*, (Columbia: University of Missouri Press, 1985), p. 22.

the falls to reach far beyond the river.[82] Combined with the national interest in conservation, this awakening to hydroelectric power led residents and business interests in the Twin Cities to question why they had wanted two locks and dams. Laying aside their longstanding feud, they began working together to convince the Corps and Congress that the project should be reviewed and revamped. Congress, going through a similar awakening, and the Roosevelt administration with its strident emphasis on conservation, readily supported the Twin Cities.[83]

D. The National Debate Over Hydroelectric Power

From 1907 to 1912, Congress and the President debated the role of the Federal government in the conservation of the nation's water resources. Hydroelectric power development became one of the most contentious areas. To conservationists, hydroelectric power meant more than using waterways to their full potential; it offered a way to pay for all waterway projects. By charging a reasonable rent for the use of dam sites in navigable waterways, conservationists believed that they could finance river improvements without appropriations from Congress. For this reason, Hays argues, "Hydroelectric power provided the financial key to the entire multiple-purpose plan."[84] Up to this time, Congress had not charged a rent or set a time limit on the leases of hydropower sites. Conservationists hoped to change this.

Power companies and the Corps opposed the conservationists. Power companies did so for obvious reasons. The General Dam Act of 1906, conservationists insisted, gave the Corps the authority to charge reasonable fees and to set time limits on leases. The Corps, backed by Secretary of War William H. Taft, held that the act only granted them the authority to regulate dams for navigation. To ensure support, Roosevelt ordered the Secretary of War and the Corps to accept his views. He could not, however, convince Congress to back him.[85]

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[82]Kane, *St. Anthony Falls*, pp. 134, 151, 154.

[83]Much of the argument in this paragraph is speculation. Why the Twin Cities changed their position on the project deserves much more research. Who initially called for a reassessment of the project for its hydroelectric power potential and why? Answers to these questions would require significant research in the official records of the Twin Cities and of the Corps of Engineers.

[84]Hays, *Conservation*, p. 114.

[85]Ibid., pp. 117-19.

To prepare a comprehensive plan for developing the nation's waterways, President Roosevelt established the Inland Waterways Commission on March 12, 1907. Conceived of and headed by W. J. McGee, an Iowa-born waterway booster and conservationist, the Inland Waterways Commission called for a multiple-purpose approach and suggested that a single agency coordinate all water resource projects. In December 1907, Senator Francis G. Newlands introduced a bill to create such an agency. This agency would have the power to investigate water resource problems, authorize projects, supervise construction, as well as coordinate the activities of all federal water resource agencies. President Roosevelt strongly endorsed the bill.[86]

Not surprisingly, the Corps and Congress opposed the Newlands' bill. The Corps generally resisted the multiple-purpose approach, as it threatened the agency's role in developing and managing waterways. The Engineers recognized that the agency proposed by Newlands would undermine much of their autonomy in selecting and building waterway projects. To get the Corps and the War Department to report favorably on the bill, Roosevelt again ordered both to support him.[87]

Many senators and representatives also rejected Newlands' bill. To allow a new agency to determine which waterway projects would be built and funded removed from Congress one of its most important and rewarding roles. Representative Burton, although a member of the Inland Waterways Commission, rejected the separate agency and introduced a proposal calling for the commission to submit another report in December 1908 and extending its life until July 1, 1909. Unable to gather enough support for Newlands' bill, the Roosevelt administration had little choice but to approve Burton's. When Congress modified the bill in other ways, the Administration became disenchanted with it. Although the House passed it on May 16, 1908, it failed in the Senate.[88]

Lock and Dam No. 1 became embroiled in this conflict. By 1913, Congress had deadlocked over the government's role in developing waterways. Opponents of the multiple-purpose approach had thwarted the program, and Roosevelt conservationists had blocked unlimited leases at hydropower sites for little or no rent. In 1908, Roosevelt began vetoing hydropower projects that did not

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[86]Ibid., pp. 102-110.

[87]Ibid., pp. 108-112.

[88]Ibid., pp. 109-114. In 1917, Congress approved Newlands' bill, but many changes called for in the bill had already been made, undermining its significance. See Swain, *Federal Conservation Policy*, p. 98.

carry such terms.[89] His successor, William H. Taft, questioned this policy. Henry L. Stimson, who became Taft's Secretary of War in 1911, however, "was enthusiastic over the possibilities of using revenue from water power to construct multiple-purpose river works."[90] In 1912, Stimson convinced Taft to veto the Coosa Dam project in Alabama because it did not provide for a rental fee. In response, Alabama Senator John Bankhead blocked a proposal by the Taft administration to develop hydropower on the Connecticut River that would have established a standard policy for hydropower development. As a result, the government became deadlocked. "This impasse brought a hiatus to hydroelectric development in navigable rivers, . . ."[91] Not until Congress passed the Water Power Act of 1920 would it establish a policy for national hydropower development.[92]

Due to this conflict, the Engineers only built the base of the power station for Lock and Dam No. 1, as the 1912 River and Harbor Act allowed them to do. After the Water Power Act of 1920 passed, Minneapolis and St. Paul, the Northern States Power Company, and the University of Minnesota submitted proposals for building a power plant at the site, but the Federal Power Commission, which

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[89]As noted earlier, Congress, in the River and Harbor Act of 1910, *Laws of the United States*, vol. 2, pp. 1419-20, provided for "reasonable compensation" from a hydroelectric power lease at Lock and Dam No. 1; *Annual Report*, 1910, pp. 1799-1800.

[90]Hays, *Conservation*, p. 119.

[91]Scarpino, *Great River*, p. 65.

[92]Hays, *Conservation*, pp. 115-121. Hays says that the 1920 act represented a compromise between conservationists and their opponents. While it permitted hydroelectric power development, it separated water power from other water-related development. This essentially ended hopes for the multiple-purpose approach for over a decade. Swain, *Federal Conservation Policy*, p. 111-121, notes that the act also created a Federal Power Commission (FPC) and formalized federal regulation of hydroelectric power development. The act gave the FPC jurisdiction over all water power sites on navigable streams, the authority to grant 50-year licenses and to regulate electrical rates and services. "Most important," Swain, p. 113, argues, "the commission received authority to require that projects be planned in accordance with a 'comprehensive scheme of improvement and utilization for the purposes of navigation, of water-power development, and of other beneficial uses . . . .'" Swain criticizes the commission, however, for being ineffective.

had been created by the Federal Power Act, rejected them.[93] In 1923, the commission finally accepted a proposal backed by the City of St. Paul and submitted by the Ford Motor Company. Ford completed the hydroelectric station in 1924, supplying power to its new truck plant on the bluff above, to the lock and dam, and to others. Over 60 years after first proposed, Minneapolis got its lock and dam and St. Paul its hydropower.

V. RIVER COMMERCE

Congress revised the project at a critical time in the history commercial traffic on the river above St. Paul, a time when the only significant traffic was dying. When the Engineers began building Lock and Dam No. 2, in 1894, lumber was the principal commerce moving on this part of the river. The millers at St. Anthony Falls and above floated their logs downriver loose and then gathered them at booms above downtown St. Paul.[94] In 1905, as the Engineers neared completion of Lock and Dam No. 2, lumber companies floated 105,000,000 feet B.M. (board measure) of loose logs down the river from St. Anthony. The Engineers estimated the value of this timber at $1,250,000. In addition, numerous steam and naphtha pleasure boats cruised the river above St. Paul, going to scenic places like Minnehaha Creek and occasionally to St. Anthony Falls.[95] By 1909, when the Corps suspended work on the project, the volume of lumber floated down the river had fallen to 88,000,000 feet.[96] Over the next several years timber shipping plummeted. In 1911, only 9,000,000 feet loose logs moved downriver between St. Anthony Falls and St. Paul. The value of the timber had fallen to about $200,000.[97] In 1914, the Engineers reported that "The only traffic on the river in 1913 consisted of excursion steamers, the larger river boats operating only to the mouth of the Minnesota River at irregular intervals. There is a considerable excursion business done by smaller boats, some of which have regular schedules, up to Minnehaha Creek, . . . The rafting of

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[93]Merritt, *Creativity*, p. 146. Hydroelectric power development at Lock and Dam No. 1 became the Federal Power Commission's Project No. 362.

[94]*Annual Report*, 1909, p. 562.

[95]Ibid., 1906, p. 1436.

[96]Ibid., 1910, p. 1801.

[97]Ibid., 1912, p. 2181.

logs below Minneapolis," the report stated, "has ceased."[98] Thus as the Engineers completed Lock and Dam No. 1, no commerce moved on the river above St. Paul. Boosters could only hope that the new lock and dam would encourage shippers to use the river. Commerce on the river above St. Paul would not become important, however, until Corps completed Upper St. Anthony Falls Lock and Dam in 1963.

VI. CONSTRUCTION

A. Lock and Dam No. 2 (Meeker Island Lock and Dam)

During the winter of 1894 to 1895, the Engineers began developing plans for Lock and Dam No. 2 or the Meeker Island Lock and Dam, but not until April 27, 1899, did they drive the first piles for the lock's cofferdam. (This lock and dam should not be confused with Lock and Dam No. 2 at Hastings, Minnesota, which the Corps completed in 1930.)[99] Problems in obtaining flowage rights and land titles for the project had caused the delay.[100] Lock and Dam No. 2 had three distinct elements. The lock comprised the east end. Two Reversed Parker bear-trap sluice gates, each 50 feet wide, and a 90-foot roll dam formed the west side. In between, the Engineers built a 431-foot roll dam.[101] By the fall of 1901, they had completed much of the lock and began constructing the dam.[102] In 1904, they installed in lower lock gate's machinery and completed the dam's middle section, removing the cofferdam. On March 30, they allowed the river to flow over the dam.[103] In 1905, the Engineers completed Lock and Dam No. 2 except for some minor riprapping and repairs to the lock floor, which had been

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[98]Ibid., 1914, p. 2483.

[99]When the Corps began building the Meeker Island Lock and Dam, the Engineers had considered building two to four dams to bring navigation to St. Anthony Falls. They began numbering the dams from downstream to upstream. Thus, Lock and Dam No. 1 was below Lock and Dam No. 2. Today, the numbering runs the downstream. Under the original numbering system, Lower St. Anthony Falls Lock and Dam (1956) and Upper St. Anthony Falls Lock and Dam (1963) would have been numbered three and four consecutively.

[100]*Annual Report*, 1895, p. 2120; Ibid., 1899, pp. 2177-79.

[101]Ibid., 1904, p. 2231.

[102]Ibid., 1902, pp. 1666-69, 1670-71.

[103]Ibid., 1905, p. 1664.

damaged when, during high water, the Engineers ran water through the lock to remove a shoal area below it.[104] By the fall of 1906, they finished most of the remaining work. On May 19, 1907, the Itura became the first vessel to pass through Lock and Dam No. 2, the first lock and dam completed on the Mississippi River.[105]

Lock and Dam No. 1

Soon after Congress passed the 1899 River and Harbor Act, the Corps began working on Lock and Dam No. 1, or what would be the first Lock and Dam No. 1. In 1900, the Engineers surveyed the site in detail and began acquiring land titles and flowage easements. Land acquisition, borings, and design occupied the Engineers for most of the next two years.[106] On May 15, 1903, they initiated construction, building a road down the bluff to the lock site on the river's west bank. By mid-June they had begun building the cofferdam for the lock.[107] High water during the fall of 1903 and the spring of 1904 delayed work, however, forcing the Engineers to build the lock cofferdam during the winter--a more difficult and expensive undertaking.[108] Not until July 12, 1905, did they complete it. Had high water not delayed the project again in 1905, the Engineers complained, they would have begun excavating the lock floor much earlier. Consequently, they excavated it from August to December 1905 and for 16 days the following May. The Engineers began digging the lock's foundation based on a general plan for the lock. Not until April 6, 1907, did the Board of Engineers approve the District's final plans.[109] The lock would match Lock No. 2 and those on the Des Moines Rapids Canal, being 80 feet by 334 feet. Over the next year and one-half, they worked on the lock, and by June 30, 1909, they had nearly completed it. During the winter, the Engineers began building the cofferdam for the dam. At

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[104]Ibid., 1905, pp. 1664, 1666. The lock had been specifically designed to have the river pass through it, the gate had been opened too fast.

[105]Ibid., 1907, p. 1578.

[106]*Annual Report*, 1900, p. 2784; Ibid., 1901, pp. 2307-08; Ibid., 1902, pp. 1671-72.

[107]Ibid., 1903, p. 1526; Ibid., 1904, p. 2231.

[108]Ibid., 1904, pp. 2232-33.

[109]Ibid., 1905, p. 1665; Ibid., 1906, p. 1435; Ibid., 1907, p. 1579.

this point, the Corps suspended work, pending the outcome of the hydropower study authorized by Congress in 1909.[110]

When Congress changed the project in the June 25, 1910, River and Harbor Act, the Engineers had to modify the lock, develop an entirely new dam design, and devise a hydropower station base for the east side. Following the act's passage, the District spent the rest of 1910, formulating plans and models.[111]

By August, the Corps' headquarters had approved the District's plans for modifying the lock, and the District immediately began construction. The new plans maintained the overall width and length but called for increasing the lock chamber's height. The new lift would be 35.9 feet. Contractors blasted out 5½-feet of the old lock floor, being careful not to damage the lock walls. They also removed the old lower miter sill and began putting the new one in.[112] The Engineers modified the lock walls, increasing their height and thickness by an innovative method. They employed "forms made of slabs of concrete which were set upon the face of the wall and cast into the permanent work." The Engineers provided interlocking joints in these slabs to strengthen the wall.[113] (See Figure 1)

During the Spring of 1911, they began working on the powerhouse, starting the cofferdam and excavating the foundation. The District submitted plans for the powerhouse to Corps headquarters and was told get advice from an expert in such designs.[114] Early in 1912, the District completed the cofferdam for the powerhouse foundation, making it large enough to include eight sluiceway sections of the dam. Complying with directions from headquarters, the District submitted the powerhouse plans to a Professor Gardner S. Williams, an expert in hydropower station design. The Chief of Engineers subsequently accepted Williams' design, which allowed for the installation of either horizontal or vertical turbines.[115] The powerhouse foundation measured 160 feet long and 112 feet wide. It contained four penstocks and one

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[110]Ibid., 1909, pp. 561, 1641, 1642; Ibid., 1910, pp. 1799-1800.

[111]Ibid., 1910, pp. 1799-1800.

[112]Ibid., 1911, pp. 1973-74.

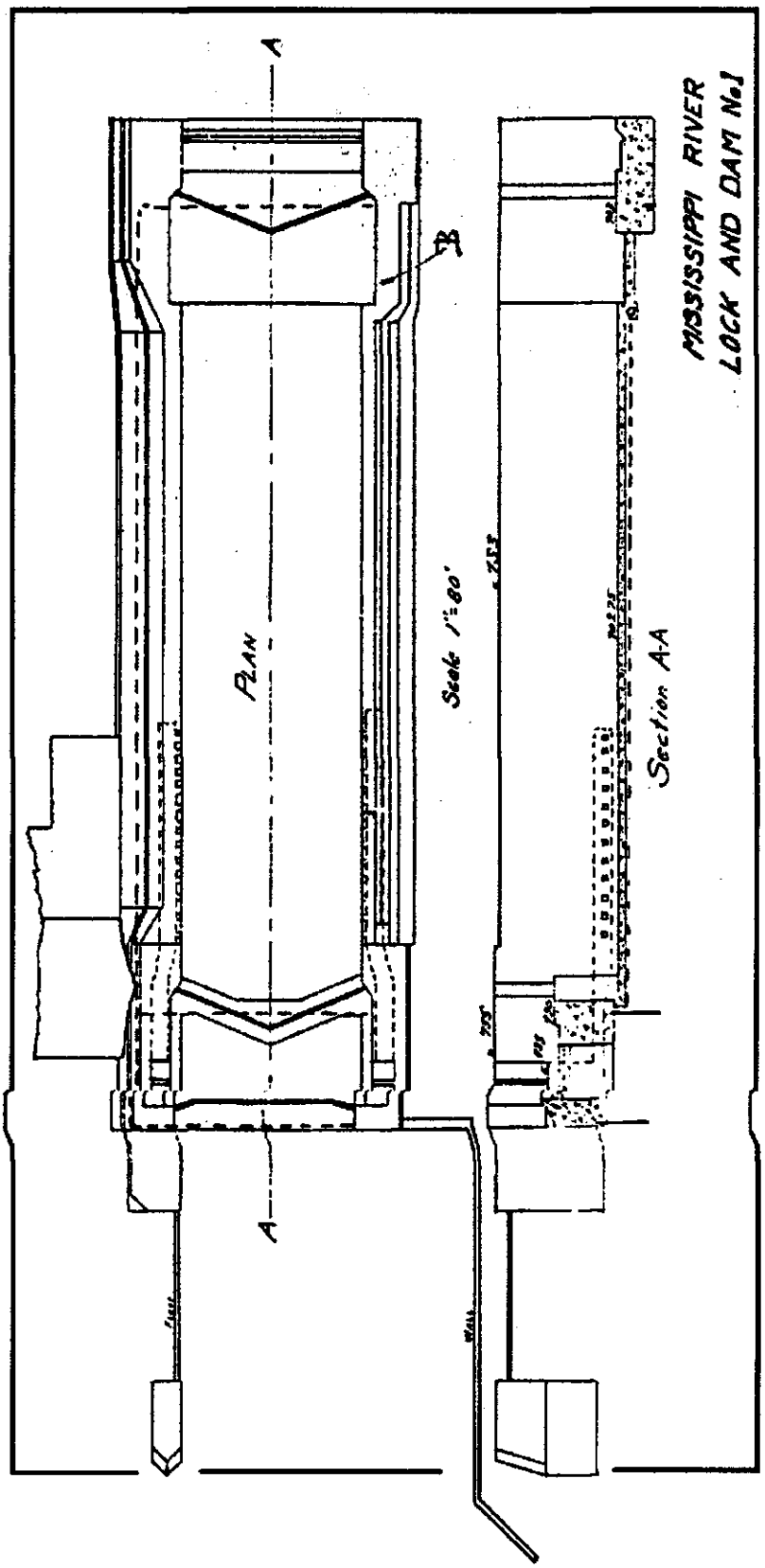
[113]*Engineering and Contracting*, "Unique Construction Methods and Devices Employed at Lock and Dam No. 1, Mississippi River Improvement," 39:12 (March 19, 1913):316; *Annual Report*, 1911, p. 1974.

[114]*Annual Report*, 1911, p. 1974.

[115]Ibid., 1912, p. 2180.

HAER, MINN, 62-SAIPA, 33-

Mississippi River 9-Foot Channel,
Lock and Dam No. 1
HAER No. MN-62
(Figure 1)
(page 35)



exciter pit, with draft tubes. From the bottom of the draft-tube floor to the top of the penstock walls was 60 feet. "The limited space," the Engineers reported, "necessitated thin partition walls, and the concrete is therefore heavily reenforced, about 435 tons of steel reenforcement being used."[116] (See HAER No. MN-62-26)

Headquarters approved the dam design in mid June 1911. Major Shunk, the St. Paul District Engineer that year, and George W. Freeman, a civil engineer with the District, selected an Ambursen dam. This dam was an innovative structure for its time, having been in use for about five years. After examining a number of Ambursen dams in the East, Shunk and Freeman were convinced that this type of structure was right for Dam No. 1, despite its youth. Still, they modified the Ambursen design in important ways, on which George W. Freeman received a patent on November 5, 1912 (see Appendix 1).[117] One of the most important adaptations was the use of precast concrete beams for the dam's surface. (See HAER No. MN-62-20 to 22) The beams attached to A-frame buttresses, spaced 16 feet apart on center. (See HAER No. MN-62-21, 24, 25 and 28) On other Ambursens, the dam's surface had been poured. In his patent, Freeman claimed that this design--by allowing workers to make the beams under heated shelters--would enable contractors to work through the cold Minnesota winters.[118] Overall, the dam spanned 568 feet, and included eight sluiceways, each 6 feet square.[119] (See HAER No. MN-62-26)

The purpose of the sluiceways remains something of a mystery. They may have been placed in the dam to deal with pollution dumped into the river above the dam. Project opponents claimed that the dam would create a cesspool behind it. C. W. Durham, a civil engineer with the Corps, reported on January 31, 1891, that "The quantity of city refuse and garbage deposited in the river is . . . on the increase. Since the city crematorium was abandoned, about 1 year ago, all the garbage and other refuse collected from this city of over 160,000 inhabitants is, I am informed, deposited in

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[116]Ibid., 1913, p. 2422.

[117]Ibid., 1911, p. 1974; Merritt, *Creativity*, pp. 143-145.

[118]See Appendix 1. In a letter to the Chief of Engineers on November 24, 1909, Major Francis R. Shunk, reported on his trip to examine Ambursen Dams in the east. In this letter he stated that these dams seemed to serve their purpose well, but that he had learned nothing to help him with his "contemplated modification, which is to substitute concrete-steel beams for a continuous sheet, thus dispensing with form-work. The question is one of leakage, and I propose, if possible, to make experiments." St. Paul District Records, St. Paul.

[119]*Annual Report*, 1915, p. 1029.

the river." Durham added that this "refuse proves not only a nuisance and a constant menace to the health of a large community along the river, but also helps to form obstructions to navigation at least as far as Prescott, Wis., 44 miles below Minneapolis, and, possibly, in Lake Pepin, some 20 miles farther." For the sake of the health of people who worked on the river--steamboat workers, river improvement workers and others--he strongly recommended that the dumping of mill refuse and garbage be stopped.[120] The Engineers probably added the eight sluiceways to the dam to deal with this problem. Historian Philip Scarpino says that each winter from 1917 to 1924, the Corps opened the sluiceways to flush out the reservoir. With the opening of the Ford Power Plant, however, they quit doing this.[121] (See HAER No. MN-62-4 to 10, 22, 23, 26, 29 and 30)

Given its uncommon design, Lock and Dam No. 1 received attention from engineering journals. According to Engineering and Contracting, "the combination of separately cast and molded in place concrete construction, and special slabs and beams" were features unique to Dam No. 1.[122] In 1912, the Engineering Record provided a long and detailed description of the dam that merits repeating here. (See HAER No. MN-62-20, 21 and 28; Figure 2)

> The method of building up the decks with concrete slabs is shown clearly in the photographs. The space between the ends of the blocks over the piers and the recesses on top are to be filled with cement mortar. The two carrying loops of imbedded cable shown about one-quarter way in from the ends are so placed that the blocks will swing into position on the piers without twisting. The steel clips on the piers below the loops at the ends are slotted to receive the threaded end of a bolt which passes through the loops of abutting blocks and thus ties the blocks down to the piers for stiffness and on the downstream deck for any uplift which might occur.
>
> Three thicknesses of blocks are being used on the upstream face rather than attempt to make a uniformly increasing thickness. To keep the weight about the same, the thicker blocks are made narrower. There are 19 blocks on the upstream deck and eight on the downstream face. Concrete for the crest is deposited in forms built on the blocks. Surface expansion

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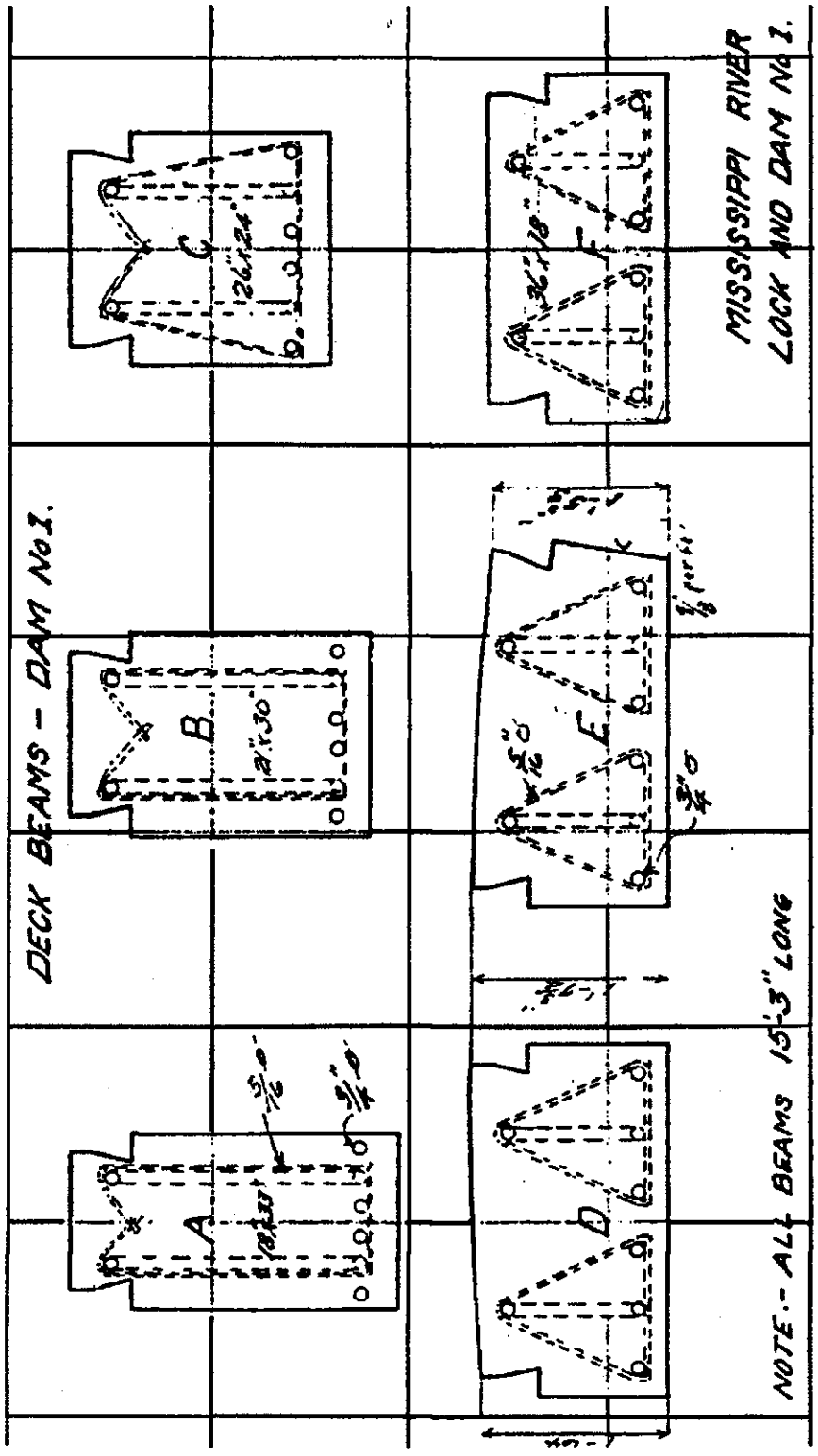
[120]Ibid., 1891, p. 2154; the first quote from Durham is in quotes in his report but he does reference a source.

[121]Scarpino, *Great River*, p. 178.

[122]*Engineering and Contracting* 39:2 (March 9, 1913):315.


DECK BEAMS - DAM No 1.
MISSISSIPPI RIVER
LOCK AND DAM No 1.
A
B
C
D
E
F
NOTE.- ALL BEAMS 15'-3" LONG

of the blocks is to be provided by the insertion of 1-in. boards in one of the longitudinal recesses between blocks.

A passageway is provided inside of the dam and rests on two of the five longitudinal beams or ties of concrete extending between the piers. Holes are left for placing them independent of the piers. Tin boxes 1-in. thick are placed between the ends of these beams over every other pier for expansion.

The reinforced-concrete foundation slab inside of the dam is perforated in each bay with six 6-in. holes to admit water from below and prevent upward pressure. As a cut-off wall under the concrete block at the toe of the dam 24-ft. Lackawanna steel sheet piling was driven into the sand, gravel, and limestone debris which was explored by drilling to 80 ft. before solid material was found. A heavy block of concrete is placed at the foot of the downstream face and open sheet piling was driven under the end of the concrete apron.

Experiments were made with a model dam of one-fifth of the actual size from which, among other things, it was determined to place the holes in the downstream deck at right angles to the face and at the tangent point of curve where water began to be deflected in a horizontal direction. The downstream face is designed as a parabola parallel to the projectory of the center line of a bar of water 10 feet deep over the crest of the dam. Under these conditions the nappe will adhere to the deck. With the holes placed as noted the maximum depth of water backing up inside the dam was obtained, hence the least pressure on the upstream deck.

Forms for the deck blocks are made of wood painted with oil. There are six reinforcing tension bars, two of which are bent up at the ends. These rods are accurately spaced by inserting in holes in the end forms. The stirrups are hooked over short rods. This arrangement is shown in the photograph, which also shows the 8-in. clamping I-beams at the bottom. A rod with hooks on each end and turn buckle in the center is placed at the end of the forms over the I-beams. The turn buckles are not tightened until the vertical pieces have been placed and the rods dropped into their slotted ends. Loosening the two turn buckles permits a removal of the four sides of the form.[123]

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[123]*Engineering Record*, 65:3 (January 20, 1912):60-61.

The Corps contracted with the Northern States Constructing Company to build the dam, as well as the hydropower station's foundation.[124]

During the fall of 1913 and early winter of 1914, the Engineers focused on the dam's powerhouse end, a section 160 feet long and containing the eight sluiceways. After completing the sluiceways and installing the machinery, they removed the cofferdam, allowing the river to flow through the sluiceways and powerhouse. Then, they built a new cofferdam to enclose the remaining section of dam. High water flooded the newly coffered area between May 4 and May 23, 1914, but receded enough for the Engineers to begin work again after the twenty-third. On June 8, however, high water again suspended work. Water rose steadily until June 29, when, "At 2:15 of that day the longitudinal section near the sluiceways broke and the water took out the lower cofferdam and undermined the three end sections (two sluiceways and one standard) of the partially completed dam at the power house side of the river."[125] (See HAER No. MN-62-24) The District had hoped to finish the dam in 1914, but the damage caused by the flood and high water during the next two years would delay completion until 1917. As of June 1914, the District reported that the lock was 98 per cent complete, the powerhouse foundation 96 per cent, the dam 54 per cent, and the whole project 77 per cent.[126]

During 1916 and early 1917, the Engineers completed the remaining work. By the end of September 1916, they finished the dam floor, demolishing the failed sections and incorporating them into the floor. In November, they built the remaining buttresses, and by April 1, 1917, they had set and grouted the concrete crest in place.[127] Salvaging the lower gates from Lock and Dam No. 2, they floated them down to Lock No. 1 and used them for the upper gates. On July 3, 1917, the Engineers officially opened the lock and dam with the passing of the U.S. lighthouse tender Dandelion. Dignitaries from both cities, joined by the St. Paul District Engineer, traveled on the Dandelion for this historic voyage, a voyage that fulfilled a vision held by Minneapolis commercial boosters for nearly 75 years. Between the old project and the new

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[124]Merritt, *Creativity*, pp. 143-145.

[125]*Annual Report*, 1914, p. 2482.

[126]Ibid., pp. 2482-83.

[127]Ibid., 1917, pp. 2733-34.

one authorized in 1910, Congress had appropriated $2,561,600 for the project.[128]

In addition to the characteristics mentioned above, Dam No. 1 is unique in other ways. The dam provided a lift of 35.9 feet, the second highest lift on the Mississippi River until the St. Paul District completed Upper St. Anthony Falls lock and dam in 1963. The hydropower dam completed by the Keokuk and Hamilton Water Power Company at Keokuk, Iowa, in 1913, had a lift of 38.2 feet.[129] Major Shunk, according to historian Raymond Merritt, "became the first officer of the Corps of Engineers to design and build a hydroelectric dam in the United States.[130] Finally, not only is Dam No. 1 the only Ambursen dam on the Mississippi River, it is the only dam in Minnesota and possibly the United States with the specific modifications Shunk and Freeman developed. Built at a time when the Corps was trying to establish and maintain a minimum 6-foot channel (1907-1930), Dam No. 1 is significantly different from Locks and Dams 3 through 26, which the Corps built as a part of the 9-foot channel project during the 1930s.

Lock and Dam 1 has undergone significant changes since completed in 1917, but the major changes have been to the lock. In 1929, the lock collapsed, stopping river traffic. To prevent such an event in the future and to fit into the new plans for a 9-foot channel project, the Engineers added a second lock in 1932. And, between 1978 and 1983, the St. Paul District completely rebuilt the lock.[131] (See HAER No. MN-62-1, 17, 18, 19; the last three photos show the addition of the second lock but also show the central control station for the lock.) The Corps has made no structural modifications to the dam proper. They added a new apron with an energy dissipator on it in about 1947. The dam has also been resurfaced. Inside the dam, the District replaced machinery in three of the sluiceways during the 1950s. Overall, however, the dam has remained the same.

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[128]Ibid., pp. 2734, 2735.

[129]Roald Tweet, *A History of the Rock Island District, U.S. Army, Corps of Engineers, 1866-1983*, (Washington: U.S. Government Printing Office, 1984), p. 262.

[130]Merritt, *Creativity*, p. 143.

[131]Gjerde, p. 123; Merritt, *Creativity*, p. 146.

VII. CONCLUSIONS

Dam No. 1 and the hydropower station at its east end symbolize important local and national events and trends. Congress authorized two locks and dams for the Mississippi River between Minneapolis and St. Paul due, in part, to the rivalry between the two cities. But, as Major Shunk insisted, no one questioned why the Engineers selected two dams, in 1894. At that time, two dams made sense to meet navigation requirements. National developments in hydropower technology and in the country's attitude toward its natural resources arrested the navigation project in full stride. Only the power of these developments--on national and local levels--explains why Congress would order a new, million dollar project destroyed and another project well into construction revamped. Those same issues created a debate so divisive that it immobilized the national government in its role in hydropower development for a decade. Lock and Dam No. 1 symbolizes this debate as well, as the Corps only had authority to build the hydropower station base and as six years passed before the Ford Company built its plant. Had it not been for these events, Major Shunk and George Freeman would not have had an Ambursen dam to modify. Inseparably intertwined, politics, economics and technology explain how Dam No. 1 came to be and why it has a unique design.

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VIII. APPENDIX 1

UNITED STATES PATENT OFFICE.

GEORGE W. FREEMAN, OF ST. PAUL, MINNESOTA, ASSIGNOR OF ONE-HALF TO JOHN R. STRYKER, OF ST. PAUL, MINNESOTA.

CONCRETE DAM.

1,043,761. Specification of Letters Patent. Patented Nov. 5, 1912.

Application filed August 14, 1913. Serial No. 715,014.

To all whom it may concern:

Be it known that I, GEORGE W. FREEMAN, a citizen of the United States, residing at St. Paul, in the county of Ramsey and State of Minnesota, have invented new and useful Improvements in Concrete Dams, of which the following is a specification.

My invention relates to an improvement in concrete dams. Its object is to provide a dam having its decks formed of a plurality of concrete beams suitably supported and bonded together to form a unitary structure.

A further object is to provide means for tying the deck beams to the buttresses of the dam to strengthen the structure and prevent any uplift of said decks.

A further object is to provide such a structure readily adaptable to the contraction and expansion of its parts.

My invention is particularly, though not exclusively, adapted for use in cold climates where if the concrete were molded *in situ*, it would be necessary to discontinue the work during the winter.

In the drawings, Figure 1 is a front elevation of the forward side of the dam embodying my invention; Fig. 2 is a sectional view of the same taken on the line 2—2 of Fig. 1; Fig. 3 is a detail sectional view taken on the line 3—3 of Fig. 1, and Fig. 4 is a detail view showing a portion of a buttress in section, an end elevation of beams and means for tying the beams to the buttresses of a dam.

Referring to the accompanying drawings, I have used the reference numeral 10 to indicate the buttresses of the dam, which may be constructed *in situ* of any suitable material. The reinforced concrete toe 13, heel 14 and crown 15 are cast in place. The decks 16 and 16′ consist of a plurality of deck-beams 17. These beams, bonded to each other and to said toe, crown and heel are tied to the buttresses 10 and form a unitary structure. All of said members are reinforced by rods in the usual manner.

The beams 17 are molded separately at any convenient place and may be built on straight lines, as illustrated, or may be curved to form either concave or convex deck sections between the buttresses of the dam. In the longitudinal corners of the upper surface of the beams 17, I mold a recess 18 to form key ways for the grouting material hereinafter specified. Each beam is supplied with a looped rod 20 embedded in one end thereof and with a second looped rod 20′ embedded in its opposite end. Sheet metal clips 21, secured to the buttresses 10 by embedded U bolts 22 and nuts 22, retain the anchor bolts 23 which pass through the looped rods 20 and 20′ of abutting beams. Nuts 24 threaded on said bolts 25 are placed in positions above and adjacent to said rods 20 and 20′. By this means I tie the beams to the buttresses 10 to secure stiffness and on the down stream deck to protect against any uplift which might otherwise occur. I prefer to slot the clips 21 to allow for variations in the width of the beams 17.

The toe 13, heel 14 and crown 15 are each formed with a recess 18 similar to those which form key ways in the beams 17. The beams are arranged to rest at their ends on adjacent buttresses and are spaced apart from each other at their ends and sides and from said toe, heel and crown. Grouting material 26 is then applied to the corrugated faces 10′ of the buttresses 10, to the spaces between said beams, toe, heel and crown including and filling the key ways formed by the recesses 18. I thus unite all of the parts of the dam into a strong structural unit.

I have provided for a slight movement of one end of each deck beam to allow for its contraction and expansion. To this end the loops of the rods 20 are wound with oakum or a like resilient wrapper 27 to prevent close contact of the grouting with said rods, thus permitting a slight expansion and contraction of the beams. The base at one end of each beam is faced with a wood or fiber sheet 28 to prevent the grouting material from binding said end to its supporting buttress and thereby provide a sliding joint. At each slidable end of said beams is a compressible wood or fiber sheet or plate 29 which permits a slight longitudinal movement of said beams.

My invention is advantageous for the reason that large forms or molds commonly used in the construction of a monolithic concrete dam may be eliminated and for the further reason that the deck beams may be conveniently constructed during any season of the year in a limited space on shore, and thereafter placed in position and bound together to form the desired structural unit.

What I claim as new and desire to protect by Letters Patent is:

1. A dam comprising a plurality of buttresses built *in situ* and decks on said buttresses consisting of separately molded concrete beams bonded to each other and to said buttresses.

2. A dam having a plurality of concrete buttresses molded *in situ*, decks on said buttresses consisting of separately molded concrete beams bonded to each other and anchor bolts on said buttresses for tying said beams thereto.

3. A dam having concrete frame-work constructed *in situ*, decks on said frame-work consisting of separately molded concrete beams, each beam having a recess in the longitudinal corners of its face, the abotting recesses in said beams being adapted to form key ways, and grouting material in said key ways and between said beams for booding the same together.

4. A dam having buttresses of any suitable material provided with a toe, heel and crown, separately molded concrete beams formed with abutting anchor recesses, like recesses in the toe, heel and crown and grooting for conding the parts together.

5. A dam having bottresses formed with corrugated bearing faces, decks on said buttresses consisting of separately moaded concrete beams, each beam having a recess in the loogitudinal corners of its face abutting a like recess in the adjacent beams, and grouting material in said recesses and between said beams and buttresses for bonding the same together.

6. A dam having a plurality of buttresses built *in situ*, decks consisting of separately molded concrete beams overlapping at their ends on said buttresses, each beam having a recess in the longitudinal corners of its face, the adjoining recesses in said beams being adapted to form key ways, a grouting material in said key ways, between each of said beams and between said beams and buttresses, a spacing sheet between one end of each beam and its supporting buttress, and a compression plate at said end of each beam.

7. A dam having a plurality of concrete buttresses, decks on said buttresses consisting of separately molded concrete beams booded to each other and anchored to said buttresses by means of bolts embedded therein, said beams being slidable at one end on the buttresses to permit expansion and contraction.

8. A dam having a plurality of buttresses, decks consisting of separately molded concrete beams resting at their ends on said buttresses, each beam having a recess in the longitudinal corners of its face, the adjoining recesses in said beams being adapted to form key ways, U bolts embedded at intervals in said bottresses, clips secured to said U bolts, anchor bolts in said clips, means for securing said beams to said bolts and a grooting material in said key ways between each of said beams and between said beams and bottresses.

9. A dam having a plurality of concrete buttresses, decks oo said botcresses consisting of separately molded concrete beams, said beams being spaced apart at their ends and sides and slidable at one of their ends on their supporting buttresses, anchor bolts secured to said buttresses, a looped rod embedded in each eod of said beams, said rods in abotting beams being adapted to receive an anchor bolt, nots oo said bolts for retaining said rods in position thereon, a resilient wrapper for the looped rods in the slidable ends of said beams and grouting for bonding the beams to each other and to the base and crown of said buttresses.

10. A dam having a plurality of buttresses built *in situ*, decks consisting of individually molded coocrete beams supported at their ends on said buttresses, each beam having a recess in the longitudinal corners of its face, the adjoining recesses in said beams being adapted to form key ways, a spacing sheet between one end of each beam and its supporting buttress, a compression plate at the same end of each beam, U bolts embedded at intervals in said bnttresses, clips secured to said U bolts, anchor bolts attached to said clips, a looped rod embedded in each end of said beams, the rods in abotting beams being adapted to receive one of said anchor bolts, nuts on said bolt for securing said rods thereto and grooting in said key ways, between each of said beams and between said beams and bottresses.

In testimooy whereof, I have signed my name to this specificatioo in the presence of two subscribing witoesses.

GEORGE W. FREEMAN.

Witnesses:
F. M. Hardy,
F. C. Caswell.

HAER, MINN, 62-SAIPA, 33-

Mississippi River 9-Foot Channel,
Lock and Dam No. 1
HAER No. MN-62
(page 47)

G. W. FREEMAN.
CONCRETE DAM.
APPLICATION FILED APR. 14, 1911.

1,043,761. Patented Nov. 5, 1912.

Fig. 1

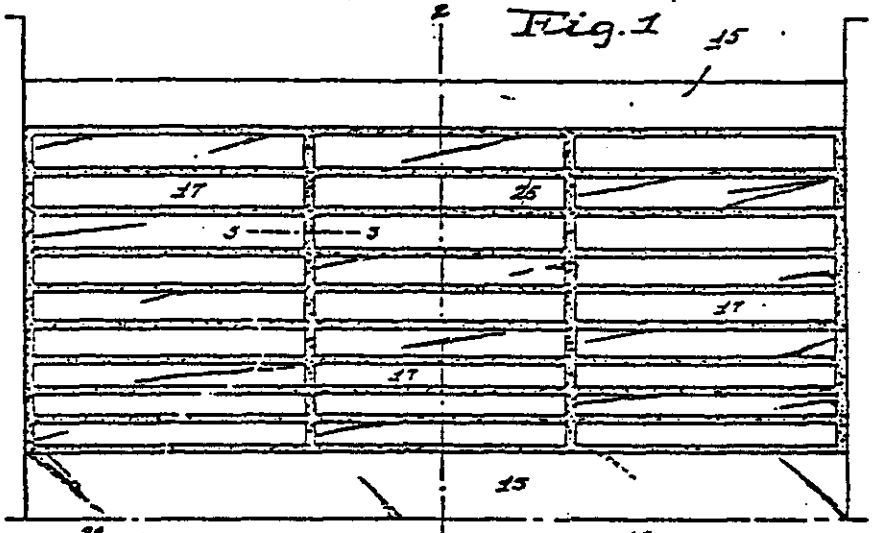

Fig. 3

Fig. 2

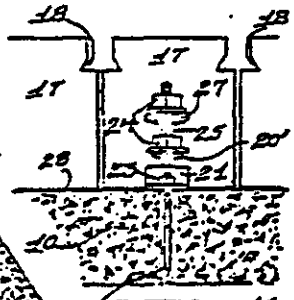

Fig. 4

Witnesses
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